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MEMORANDUM FOR ASSISTANT FOREST ENTOMOLOGIST?, J. M. MILLER ON EXPERIMENTS CONDUCTED BY THE ASHLAND STATION IN THE JENNY CREEK AREA, OREGON. DURING THE SUMMER OF 1920.

EXPERIMENTS

Artificial Attraction of Dendroctonus brevicomis.

Attraction of Dendroctonus brevicomis to felled trap trees.

Attraction of Dendroctonus brevicomis to Girdled Trap Trees.

Burying Bark Infested With Dendroctonus brevicomis To Kill Broods.

Solar Heat Method of Control of Dendroctonus brevicomis.

J. E Patterson

ASHLAND, OREGON.
December 14,
1920

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During the summer season of 1920 a series of experiments were carried out by the Ashland Station in the Jenny Creek Area of southern Oregon with the object of making available additional data on methods of control of the Western pine bark beetle, Dendroctonus brevicomis.

These experiments were located in Sec. 33, Twp. 39, S. Range 4 East; Willamette Meridan. Longitude 122 degrees; 20 min. West - Latitude 42 degrees; 5 min. North. Elevation (mean) 3,600 feet. The location was near ideal for the purpose in many respects, being near the center of the large Jenny Creek belt of pine timber, an almost virgin forest, readily accessible though isolated sufficiently from the merely curious to assure the experiments freedom from molestation. Suitable living timber for all needed purposes was also available in desirable locations. In addition; a normal infestation of Dendroctonus brevicomis existed throughout the forest. This latter was an absolute requisite for the success of the experiments.

The investigations were carried out in connection with a road slash study in the same area; making it possible and convenient to operate from one central camp.

The following memorandum presents these experiments and the results obtained.

OUTLINE OF EXPERIMENTS:

EXPERIMENT NO. 1 - Artificial attraction of Dendroctonus brevicomis to living yellow pine trees by forcing initial attacks into base of tree.

EXPERIMENT NO. 2 - Attraction of Dendroctonus brevicomis to felled trap trees.

EXPERIMENT NO. 3 - Attraction of Dendroctonus brevicomis to girdled trap trees.

EXPERIMENT NO. 4 - Burying bark infested with Dendroctonus brevicomis in soil to kill the broods of the beetle.

EXPERIMENT NO. 5 - Solar heat method of control: Exposing yellow pine bark infested with Dendroctonus brevicomis to the direct rays of the sun to determine the practicability of this method of control in this latitude and ranges of elevation.

EXPERIMENT NO. 1 - ARTIFICIAL ATTRACTION OF DENDROCTONUS BREVICOMIS TO LIVING YELLOW PINE TREE. HOPK U. S. NO. 16236.

OBJECT: To obtain additional data on attraction study of the Dendroctonus group of barkbeetles and to supplement similar experiments conducted near Ashland, Oregon, in May and June, 1919. (This latter experiment was recorded under Hopk. U. S. No. 16200). It was also believed that data would be obtained relative to the distance from the test tree this attractive element affected the beetles.

PROCEEDURE: A living, healthy, yellow pine tree; 36 inches D.B.H. and 150 feet in height, was selected. In selecting this tree particular attention was given in order to obtain a tree of average size, average exposure, average vitality, etc., so that the results of the experiment would be applicable to the average yellow pine tree. A framework of wood consisting of 2 x 4 inch dimension material was constructed around the base of the tree. This frame was 8 x 8 feet square and 12 feet high. It was covered with "Cabot" muslin and the soil was heaped up around the bottom. The cage was made absolutely insect proof. (See attached photograph).

Yellow pine bark infested with a brood of Dendroctonus brevicomis was collected and put in the cage around the base of the tree. It was expected that when the adult beetles emerged from this bark that they would attack the caged portion of the tree as it would be impossible for them to escape from the cage.

After the bark was placed in the cage and the entrance closed a survey of the surrounding forest within a radius of 1/4 mile was made and all infested trees containing bark-beetles were located and treated. Two trees infested with D. brevicomis were found in this area; these were felled and the bark burned. On completion of this control work the caged tree was located in the center of a circular area 1/2 mile in diameter that was entirely free from barkbeetle infestation. In the event that the uncaged portion of the tree was attacked by beetles from the surrounding forest it would necessitate a flight of these beetles of at least 1/4 mile from the brood trees.

PROGRESS:

May 27, 1920: Infested bark was removed from a yellow pine tree infested with and overwintered brood of the second of Dendroctonus brevicomis of the "C" or 1919 attacks. On this date this brood was in the full grown larvae, pupae, and new adult stages of development.

June 10, 1920: First emergence of adults from bark within the cage. 50 new adults were counted on inside north wall of cage. None had attacked the tree.

June 20: 1920: Heavy emergence of new adults from bark. A few beetles have attacked the tree but they have been drowned out by the flow of sap.

July 9, 1920: Maximum emergence from bark is over. A few new adults still coming out. Many live adults on walls of cage and on trunk of tree. Also many dead adults on floor of cage. Many adults have attacked caged portion of tree but all have been drowned out by sap flow. A few pitch tubes were noted on trunk of tree above cage; these attacks had also failed due to the heavy flow of sap into the burrows.
A few adult Acanthocenis spectabilis were collected from outside walls of cage. A number of Clerid adults, Clerus sphegeus, were also collected from outside walls of the cage.

July 19, 1920: A few live adults on inside walls of cage. Attacks on tree have all failed both within and above the cage.

August 3, 1920: Beetles within the cage have all died and all attacks on tree have failed. The bandoned bark was removed from the cage. The area surrounding the caged tree was again cruised to locate and treat the infestation if any had come in since the first cleaning. None was found and the area was still clean.
In fested bark from yellow pine tree No. D13 was brought to cage and placed inside. This bark contained a 1st "D" or 1920 generation brood of Dendroctonus breviconis in full grown larvae, pupae, and new adult stages.

Aug 13, 1920: Large emergence from bark within the cage. Many adults have attacked tree within cage; these appear to be making good. A few fresh attacks appear on the tree above the cage. Many adults of the Clerid predator, Clerus sphegeus, were crawling over bark on tree above the cage and many more were running rapidly over the outside walls. Many pairs were noted mating, both on walls of cage and on bark of tree. A number of adults of the Dipterous parasite, Medeterus aldrichii, were noticed running about in the crevices of the bark on the tree above the cage. Many adult barkbeetles were noticed on the outside walls of the cage.

Aug 18, 1920: Heavy emergence has occurred inside the cage. Many of

these adults have attacked tree within the cage but no new attacks were noted on tree above cage.

Sept 2, 1920: Emergence from bark within the cage over. Very few adults alive. Many have attacked the tree and have met with successful resistance by the sap flow. Hundreds of new attacks have been made on the tree above the cage and these are successful.

Sept 18,1920 Adults inside cage have all died and all attacks within the cage have failed. Tree above the cage has been attacked all-round as high up as it was possible to distinguish pitch tubes; probably to the top. These attacks have mostly been successful and the tree will die. Parent adults are still excavating brood galleries. The new brood consists of eggs, and young larvae about 1/8 grown.

Oct 4, 1920: A few parent adults are still alive in the galleries. New brood as last eggs and maximum larvae about 1/4 to 1/2.

Oct 16, 1920 Parent adults all dead. Brood all larvae 1/2 to 3/4.

Nov 11, 1920 Brood all larvae, 3/4 to 1; in outer bark. Foliage of tree is still normal green. (Last record).

RESULTS:

Flying beetles from the field were attracted and drawn to the caged tree. The distance these beetles flew from the brood trees was at least 1/4 mile. Owing to the possibility that many beetles were flying in the cleaned area surrounding the tree, throughout the summer period of flight, it was impossible to determine, with any degree of accuracy, the distances from the tree that the flying beetles were attracted to it.

First attempt to overcome the tree failed although the caged portion was fairly well attacked and a few attacks were made above the cage by beetles from the field. However, none of these attacks made good.

Second attempt was successful in attacking and overcoming the tree above the cage by beetles from the field, although attacks on the caged portion was unsuccessful.

The period of maximum attack by beetles from the field on the uncaged portion of the tree occurred approximately 15 days

after first attacks inside cage. First adults from the field attacked uncaged portion of tree at approximately the same time that first attacks occurred inside cage.

The predator, Clerus sphegeus? and the parasite, Medeterus aldrichii, arrived at tree at about the same time as the barkbeetles.

No other living trees adjacent to the caged tree were attacked although a number of such were standing in close proximity.

CONCLUSIONS

That a zone of attraction exists to some distance around a tree during the period of attack by barkbeetles seems undisputable. This attraction is effective with both barkbeetles and their insect enemies. What constitutes the attrcation is as yet unknown. The distance this attraction influences the beetles was not postively determined though it would seem to be at least 1/4 mile.

The beetles do not attack in swarms. Initial attack is made bya few individuals; reaching a maximum of attack within 7 to 15 days. The period of attack covers a cycle of approximately 30 days duration.

That the average yellow pine tree successfully resists initial attacks of a hundred or two beetles, and that the lower trunk offers the greater resistance.

Parasites and predators of Dendroctonus brevicomis arrive at a tree which is being attacked at approximately the same time as the barkbeetles.

Plate I

Type of cage used in Experiment No. 1, (Hopk. U. S. No. 15236). This photograph shows the construction of the cage and its position around the base of the tree. A fence was later built around the cage to prevent range stock from injuring it.

EXPERIMENT NO. 2 - ATTRACTION OF DENDROCTONUS BREVICOMIS TO FELLED TRAP TREES. HOPK. U. S. NO. 16237.

OBJECT:

To determine the best periodsduring the flight period of Dendroctonus brevicomis when trap trees are most effective in drawing infestation at this latitude and elevation. (2) To obtain brood records on the development of broods of this beetle in trap trees and the proper time to treat infested trap trees felled at different periods during the summer season.

PROCEDURE:

Average yellow pine trees were selected in situations where normal forest conditions prevailed. These trees were felled with saws and axes. Each was given a sporate number for identification. Records were kept on the broods throughout the season.

DEVELOPMENTS:

Trap tree No. D1 - 20 inches D.B.H. Height 70 feet.

Date	Condition of brood
May 28, 1920	Tree felled.
June 4	First attack; first P.A.
" 10	Maximum attack; first eggs
July 9	Last attack; last eggs; maximum larvae $\frac{1}{4}$
" 12	" " " " " " "
" 19	Last P.A. maximum larvae $\frac{1}{2}$-$\frac{1}{4}$
" 22	Maximum larvae $\frac{1}{2}$-$\frac{3}{4}$
August 3	Maximum larvae $\frac{3}{4}$-1; First pupae
" 9	Last larvae; maximum pupae
" 18	Maximum pupae; first new adults
Sept 2	Last pupae; max. new adults; max. emergence
Sept 18	Abandoned; brood all out.

Trap tree No. D2 - 14 inches D.B.H. Height 60 feet.

Date	Condition of brood
May 28	Tree felled
June 10	
July 9	
" 19	First attack; first P.A.
" 26	Maximum attack; first eggs
August 3	Last attack; maximum eggs; first larvae
" 9	Last eggs; maximum larvae 1/8 - $\frac{1}{4}$
" 18	Maximum larvae $\frac{1}{4}$ - $\frac{1}{2}$
September 2	Maximum larvae $\frac{3}{4}$ - 1; first pupae
" 18	Last larvae; max. pupae; first new adults
October 4	Last pupae; max. N.A. Emergence
" 16	Max. N.A. Max. emergence
November 11	Abandoned; brood all out

Trap tree No. D3 - 30 inches D.B.H. Height 100 feet.

Date	Condition of brood
May 28	Tree felled
June 4	First attack; first P.A.
" 10	Maximum attack; first eggs
July 9	Last attack; last eggs; maximum larvae $\frac{1}{4}$
" 12	" " " " " "
" 19	Last P.A. maximum larvae $\frac{1}{4}$ - $\frac{1}{2}$
" 22	Maximum larvae $\frac{1}{2}$ - $\frac{3}{4}$
August 3	Maximum larvae $\frac{3}{4}$-1; first pupae
" 9 XH	Last larvae; maximum pupae
" 16	Maximum pupae; first new adults
September2	Last pupae; max new adults; max emergence
" 16	Abandoned; brood all out.

Trap tree No. D4 - 20 inches D.B.H. Height 100 feet.

Date	Condition of brood
July 12	Tree felled
" 15	First attack; first P.A.
" 22	Maximum attack; max P.A.; first eggs
August 3	Last attack; maximum eggs; first larvae
" 9	Last eggs; maximum larvae $\frac{1}{4}$
" 16	" " " " $\frac{1}{4}$ - $\frac{1}{2}$
September 2	Maximum larvae $\frac{1}{2}$ - 1; first pupae
" 18	Last larvae; maximum pupae; first N.A.
October 4	Last larvae; last pupae; max N.A. Emergence
" 16	Last new adults; last emergence
November 11	Abandoned; brood all out

Trap tree No. D5 - 24 inches D.B.H. Height 110 feet.

Date	Condition of brood
July 12	Tree felled
" 15	
" 22	First attack: first P.A.
August 3	Maximum attack: maximum eggs: first larvae
" 9	Last eggs: maximum larvae $\frac{1}{4}$
" 18	" " " " $\frac{1}{4}$ - $\frac{1}{3}$
September 2	Maximum larvae $\frac{1}{3}$ - 1: first pupae
" 18	Last larvae: maximum pupae: first new adults
October 4	Last pupae: maximum new adults: max emergence.
" 16	Last N.A. Last emergence
November 11	Abandoned: brood all out

Trap tree No. D14 - 28 inches D.B.H. Height 130 feet.

Date	Condition of brood.
August 13	Tree felled
" 21	First attack: first P.A.
September 2	Max attack: max P.A. first eggs
" 18	Last attack: maximum eggs: first larvae
October 4	Last eggs: maximum larvae $\frac{1}{2}$ - $\frac{1}{3}$
" 16	Maximum larvae $\frac{1}{3}$ - 1
November 11	Maximum larvae - 1: (Last record of season)

Trap trees No. D15 - 24 inches D.B.H. Height 110 feet.

Date	Condition of brood
August 13	Trees felled
" 21	First attack: first P.A.
September 2	Max attack: max P.A. first eggs
" 18	Last attack: maximum eggs: first larvae
October 4	Last eggs: maximum larvae $\frac{1}{4}$ - $\frac{1}{3}$
" 16	Maximum larvae $\frac{1}{3}$ - 1
November 11	Maximum larvae - 1: (Last record of season)

RESULTS:

All trap trees felled were attacked and with the exception of D2 all developed large broods.

The accompanying chart shows the development event first dates.

EXPERIMENT NO. 2 - TRAP TREES: CHART OF ATTACK AND DEVELOPMENT OF BROODS.

Tree No.	Date felled	Brood development and event periods											
		Attack		Larvae		Pupae		New Adults		Emergence			
		First date	No. days after felling	First date	No. days after felling	First date	No. days after felling	First date	No. days after felling	First date	No. days after felling	First date	No. days after felling
D1	May 28	June 4	7	July 1	53	Aug 3	66	Aug 18	81	Aug 25?	88		
D2	May 28	July 19	51	Aug 3	66	Sept 2	96	Sept 18	112	Oct 4	128		
D3	May 28	June 4	7	July 1	33	Aug 3	66	Aug 18	81	Aug 25?	88		
D4	July 12	July 15	3	Aug 3	22	Sept 2	52	Sept 18	68	Oct 4	84		
D5	July 12	July 22	10	Aug 3	22	Sept 2	52	Sept 18	68	Oct 4	84		
D14	Aug 13	Aug 21	8	Sept 18	36								
D15	Aug 13	Aug 21	8	Sept 18	36								

EXPERIMENT NO. 2 - Diagram No. I.

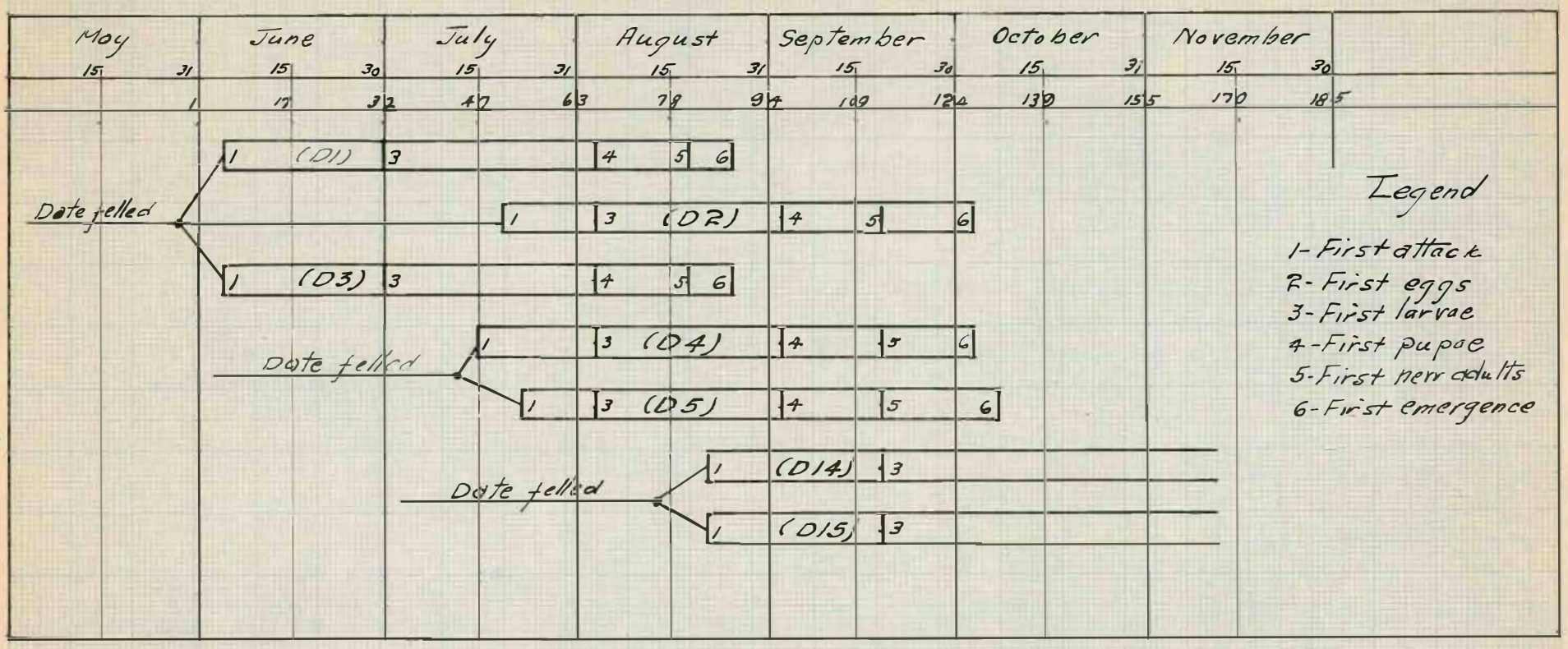


Diagram illustrating development event periods of Dendroctonus brevicomis broods in trap trees felled in Jenny Creek Area, Oregon. 1920. Long: 122 deg. 20 min. Lat: 42 deg. 5 min. N. Elevation 3,600 feet.

EXPERIMENT NO. 3 - ATTRACTION OF DENDROCTONUS BREVICOMIS TO GIRDLED TRAP TREES. HOPK. U. S. NO. 16238.

OBJECT:

To determine if girdled, standing, trap trees are as attractive to Dendroctonus brevicomis as felled trap trees. Also to determine, in the event that these trees were attacked, the relative development of the broods as compared with felled trap trees.

PROCEEDURE:

Average yellow pine trees were girdled to the heartwood and left standing in the forest. By girdling is meant cutting, with axes, entirely through the sapwood clear around the trunk. This practically cuts off the upward flow of sap.

Three trees were selected for the experiment:

Tree No. 1 - 12 inches D.B.H. Height 50 feet. Girdled May 28.

Trees No. 2- 14 inches D.B.H. Height 60 feet. Girdled May 28.

Tree No. 3 - 30 inches D.B.H. Height 120 feet. Girdled May 28.

RESULTS:

Records were kept on these trees throughout the summer. The last examination was made November 11; on this date the trees were all green and none of them had been attacked by Dendroctonus brevicomis. A few pitch tubes of Dendroctonus valens had appeared on the trunks near the ground on trees number 1 and 3 but on examination of these tubes it was found that the beetles had all been drowned out.

EXPERIMENT NO. 4 - BURYING BARK INFESTED WITH DENDROCTONUS BREVICOMIS TO KILL BROODS OF THE BEETLE. HOPK. U. S. NO. 16239.

OBJECT:

To determine the effectiveness and practicability of killing broods of Dendroctonus brevicomis in yellow pine bark by burying the bark in the ground.

PROCEEDURE:

On July 27, 1920, 3 sections (A, B, C,) of bark was removed from trap tree D3 and buried in the ground near the tree. This bark contained full grown larvae and pupae of the beetle.

Later, on August 7, 3 additional sections, (D, E, F,), from D13 brood tree, containing full grown larvae, pupae and new adults, was buried at the same place with the first sections.

The pits in which the bark was buried were excavated in mineral soil and the bark was covered with this soil.

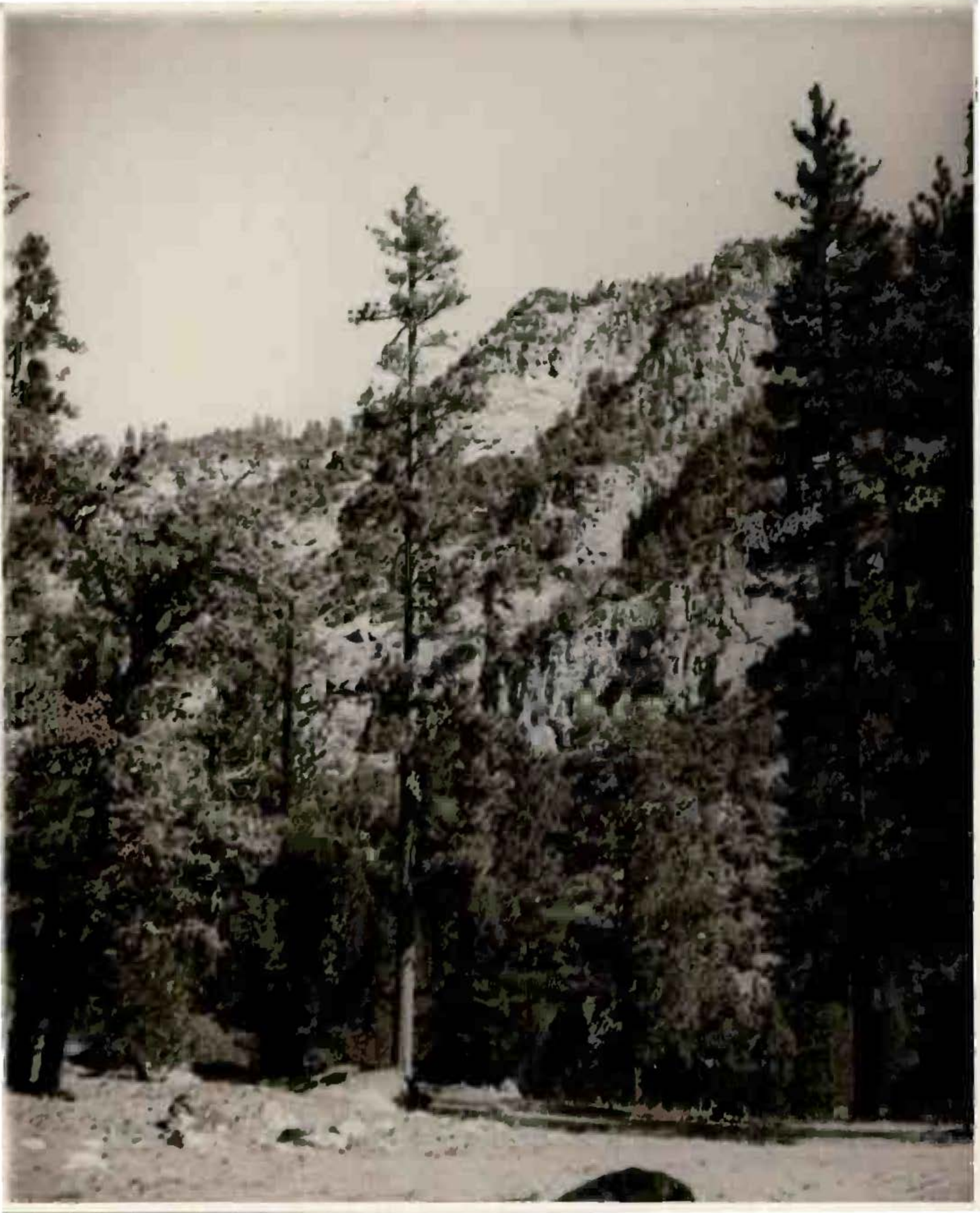
RESULTS:

The bark was carefully examined October 15 and it was found that the insects were all dead.

The following table gives the details of this experiment.

EXPERIMENT NO. 4 - YELLOW PINE BARK INFESTED WITH DENDROCTONUS BREVICOMIS BURIED IN GROUND.

Bark section designation	Date of burial	Depth buried: inches	Date excavated	Size of section: sq. ins	Stage of brood when buried	Entrance holes number	Ventilation holes number	Condition of brood when examined October 15, 1920.
A	Jul 13	4	Oct 4	77	larvae pupae	2	14	All dead
B	"	8"	"	88	larvae pupae	2	13	All dead
C	"	12	"	60	larvae pupae	1	11	All dead
D	Aug 7	3	"	60	larvae pupae N.A.	1	20	All dead
E	"	5	"	72	larvae pupae N.A.	2	14	All dead
F	"	7	"	60	larvae pupae N.A.	1	25	All dead



EXPERIMENT NO. 5 - YELLOW PINE BARK INFESTED WITH DENDROCTONUS BREVICOMIS SUBJECTED TO SOLAR HEAT TO KILL BROODS OF THE BEETLE.
Hopk. U.S. No 16240

OBJECT: To determine the practicability of killing broods of the Western pine beetle, Dendroctonus brevicomis, Lec., by subjecting the infested bark to the direct rays of the sun under normal forest conditions.

This series of experiments was conducted to add additional data to that already in hand and obtained through investigations, and field and laboratory experiments, conducted in the summer of 1919 in the Sequoia National Park and at the Ashland Station in the winter of 1920. The data is also intended to supplement similar experiments conducted by Assistant Forest Entomologist, J. M. Miller in connection with control work on the Sierra National Forest, California, during the past spring and summer.

The experiments were located and performed in Sec. 33, Twp. 39, S. R. 4 East, Willamette Meridan. Elevation 3,600 feet. Period; July 15 to August 16, 1920.

METHOD: Sections of yellow pine bark infested with broods of the beetle, in different stages of development, were exposed to direct sunlight, under normal forest conditions, throughout the greater portion of the day. An even number of sections were exposed in the shade for comparison of results. Temperature records were kept throughout the period of the tests by means of tested thermometers of ordinary design; specially constructed thermometers and a Richard thermograph. Dialy records of humidity were made by using a U. S. Weather Bureau standard sling psychrometer and psychrometric tables. These tests were made between the hours 8:00 AM and 6:00 PM at intervals of two hours in order to ascertain the relative humidity which obtained during the period of the experiments.

In addition; records of sunlight intensity, or solar haet, were made by the readings of a specially constructed thermometer designed for this purpose.* Readings of this "black-bulb thremometer" were taken at intervals of two hours between 8:00AM and 6:00 PM.

*This instrument was constructed by attaching two tested Taylor thermometers side by side to a wood support. The bulb of one thermometer was coated with lamp black dissolved in turpentine and shellac Both were exposed to direct sunlight and as the black bulb absorbed more heat than that of the ordinary thermometer it recorded the temperature higher indicating the intensity of the suns rays or the amount of solar heat present.

It was aimed to conduct the experiments so that the actual temperatures obtained in the infested bark would be determined for exposures both normal and abnormal, in shade and in sunlight, and to determine the effect on the broods of the beetle as a result of these exposures.

EXPERIMENT 5a.

Proceedure: Infested yellow pine bark was removed from trap tree No. D3; Jenny Creek Unit. This bark contained a brood of Dendroctonus brevicomis in the nearly one-half grown larval stage. The larvae had fed through the cambium layer and had just recently entered the inner layers of the outer bark. The bark was cut into 42 sections of 12 x 10 inches in size. 21 sections were placed, cambium surface up, on the ground in the open forest where they would be exposed to the direct rays of the sun between the hours 9:00AM and 5:00Pm. The other 21 sections were placed, cambium surface up, on the ground in position where at no time was it possible for the sunlight to strike them. (These positions of exposure were designated: A- Sunlight; B- Shade.).

A photographic stirring rod thermometer was imbedded in one section of bark in each exposure to obtain the temperatures reached in the inner layers of the bark. These thermometers were read daily at intervals of two hours from 8:00AM to 6:00PM.

Two sections of the trunk of trap tree No. D1; Jenny Creek Unit, (yellow pine tree infested with a brood of D. brevicomis in same stage of development as the proceeding) were sawed out, one section was rolled into exposure A: sunlight; and the other section was rolled into exposure B: shade. Each section was eight feet long and 22 inches in diameter. The infested bark on these sections was not disturbed in any way but was left in normal position on the logs. A stirring rod thermometer was imbedded in the upper arc of each log so that the bulbs were in the same plane with the cambium layer. Daily temperature readings of these thermometers were taken at intervals of two hours to determine the temperature that the inner bark was subjected to. The tube and scale of the thermometer placed in the log in exposure A was shaded by means of a wooden bracket to prevent the suns rays from affecting the registering.

The sections of bark and logs were placed in these designated positions on July 15 and the tests were started at 8:00 AM on this date.

At the close of the daily tests, at 6:00PM each day, one section of bark from each exposure was removed, examined and placed inside a small building where they were kept until September 1 when a complete cutting test was made of them to determine the results of the exposure.

The technique of this experiment provided that the sections removed the first day would have had one days exposure; the sections removed the second day, two days exposure, and so on until, at the close of the experiment, on Aug 4, the last sections removed would have had 21 days exposure.

The daily temperatures recorded, psychrometer readings, and readings of the intensity of the suns rays, recorded during this experiment are given in the attached tables.

Results:

The preliminary examinations, made the first day of the first sections of bark removed, indicated that the entire brood in these sections had been killed by the exposure. Apparently the exposure in both sunlight and shade had been fatal. The subsequent cutting test and careful examination made of the sections on September 1 substantiated the first examination. During the first days exposure the edges of the sections of bark, in both positions, curled upward concaving on the cambium side and it was noticed that that the cambium itself had been completely dried as a result of the excessive evaporation.

Frequent examinations of the infested sections of trap tree No. D1 showed that the broods in all sections were developing normally and on Sept 2 a maximum emergence of adults from these sections was recorded. On September 18 the sections were abandoned as shown by the attached brood record. From a comparison of the number of exit holes counted in the bark of these sections of log, after emergence was over, it was proven that the position of the logs did not have any noticeable influence on the mortality of the broods. It was also noticed that the emergence of adults from the upper arc of the logs was as great as that from the two lateral sides showing that the higher temperatures reached in the bark on this portion of the logs did not affect the mortality of the broods.

Conclusions:

It is evidentfrom this test that undervidentical conditions and during the early larval stage Dendroctonus brevicomis broods within peeled bark, placed with cambium side up even in shaded and relatively cool positions, are not capable of surviving

one days exposure to the air under normal forest conditions. It was considered however, that this test did not furnish sufficient evidence to warrant the assumption that the method would be successful with broods of the beetle in more advanced stages. Further tests were planned for later in the season when it would be possible to get broods further advanced for at the date this experiment was started it was not possible to obtain bark infested with broods in any stage of development except early larval.

It appears from these tests that when infested bark is left undisturbed on the log that temperature, solar heat, and other factors, which normally prevail, do not appreciably affect the mortality of the broods.

EXPERIMENT NO. 5a - DAILY MAXIMUM AND MINIMUM TEMPERATURES OF AIR AND OF EXPOSED BARK AND CORRESPONDING RELATIVE HUMIDITY AND INTENSITY OF SOLAR HEAT.

Date	Bark Section Number	Air Temperature		Bark Temperature				Relative Humidity (%)		Maximum Intensity of Solar Heat	Condition of brood when examined at close of test and on Sept 1st.	
				Secs in Sun (A)		Secs inshade (B)						
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum		Secs. in shade	Secs. sun
July 15	1	82	35	108	55	76	52	34	16	10	All Dead	All dead
" 16	2	86	39	106	60	77	58	33	15	13	" "	" "
" 17	3	87	35	108	56	75	53	38	15	10	" "	" "
" 18	4	86	38	110	56	76	51	45	15	10	" "	" "
" 19	5	81	40	115	60	73	58	65	19	12	" "	" "
" 20	6	79	40	115	70	73	56	74	34	12	" "	" "
" 21	7	72	41	102	68	67	54	68	45	12	" "	" "
" 22	8	89	33	118	46	77	45	71	19	10	" "	" "
" 23	9	88	39	119	51	80	50	70	19	8	" "	" "
" 24	10	81	41	112	50	75	49	70	20	10	" "	" "
" 25	11	88	39	118	44	88	43	63	18	10	" "	" "
" 26	12	91	43	120	52	84	52	72	14	10	" "	" "
" 27	13	94	43	122	51	85	50	82	13	9	" "	" "
" 28	14	91	45	122	51	83	50	81	9	10	" "	" "
" 29	15	85	41	115	46	78	50	78	3	12	" "	" "
" 30	16	82	38	112	42	78	48	50	20	12	" "	" "
" 31	17	89	40	118	48	82	50	63	20	10	" "	" "
Aug 1	18	92	44	120	48	84	50	58	12	8	" "	" "
" 2	19	91	47	120	50	80	52	77	25	8	" "	" "
" 3	20	91	41	120	50	84	50	68	21	22	" "	" "
" 4	21	94	43	121	62	80	56	54	12	8	" "	" "

EXPERIMENT NO. 5a - DAILY MAXIMUM AND MINIMUM TEMPERATURES OF AIR AND OF BARK ON EXPOSED SECTIONS OF TRAP TREE NO. D 1.

Date	Air Temperature		Bark Temperature				Percent of Relative Humidity	
			Secs. in sun		Secs in shade			
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
July 15	82	35	90	60	70	56	34	16
" 16	86	39	90	60	70	58	33	15
" 17	87	35	92	60	71	55	38	15
" 18	86	38	92	60	71	57	45	15
" 19	81	40	98	66	70	58	65	19
" 20	79	40	94	75	70	58	74	34
" 21	72	41	84	70	65	50	68	45
" 22	89	33	95	58	72	50	71	19
" 23	88	39	102	62	74	51	70	19
" 24	81	41	100	60	72	50	70	20
" 25	88	39	102	64	72	54	63	18
" 26	91	43	106	66	78	58	72	14
" 27	94	43	110	66	80	58	82	13
" 28	91	45	108	68	78	60	81	9
" 29	85	41	102	66	74	58	78	3
" 30	82	38	102	60	72	56	50	20
" 31	89	40	104	62	76	54	63	20
Aug 1	92	44	106	60	74	50	58	12
" 2	91	47	104	66	78	60	77	25
" 3	91	41	102	64	77	58	68	21
" 4	94	43	100	72	76	60	54	12
" 5	88	47	94	70	75	62	66	20
" 6	85	42	98	64	76	58	70	28
" 7	96	44	105	64	82	58	64	16
" 8	90	55	96	72	70	66	77	28
" 9	82	48	90	64	73	58	94	35
" 10	98	46	102	65	82	60	88	21
" 12	100	44	100	64	84	58	88	16
" 13	103	47	104	68	87	61	51	16
" 14	104	50	106	66	90	62	59	18
" 16	99	50	100	72	84	64	55	16

EXPERIMENT NO. 5a - RECORD OF DEVELOPMENT OF BROOD IN TRAP TREE NO. D1.

(In sections exposed in both sunlight and shade and also in remaining portion of tree which was not disturbed from position taken when felled)

LOCALITY: Sec. 33- Twp. 39- S.R. 4 E. Willamette Mer.
ALTITUDE: 3,600 feet.
TREE: Yellow pine.
SIZE: 22 inches D.B.H. - Height 80 feet.
INSECT: Dendroctonus brevicomis, Lec.

Date	Condition of brood
May 28	Tree felled
June 4	First attack; first P.A.
June 10	Maximum attack; first eggs
July 9	Last attack; last eggs; Max. larvae $\frac{1}{4}$
" 12	" " " " " "
" 19	Last P.A. Maximum larvae $\frac{1}{4}$ - $\frac{1}{2}$
" 22	Maximum larvae $\frac{1}{2}$ - $\frac{3}{4}$/
August 3	Maximum larvae $\frac{3}{4}$ - 1; First pupae
" 9	Last larvae 1; Maximum pupae
" 18	Maximum pupae; First new adults
Sept 2	Last pupae; Max. new adults; Max emerg.
" 18	Abandoned; Brood all out

TEMPERATURE RECORDS OF BARK EXPOSED WITH INNER SURFACE UP AT JENNY CREEK CAMP OREGON. PERIOD JULY 15 - AUGUST 16, 1920.

Longitude 122 degrees, 20 min. West.
Latitude 42 degrees, 5 min. North.
Elevation 3,600 feet.

Date	Time of day	Temperature in degrees Fahr. (A) Sections in sunlight	(B) Secs in shade
July 15	8: AM	55	52
	10: AM	86	60
	12: M	108	67
	2: PM	108	72
	4: PM	108	76
	6: PM	85	76
July 16	8: AM	60	58
	10: AM	75	63
	12: M	106	73
	2: PM	104	77
	4: PM	82	75
	6: PM	86	75
July 17	8: AM	56	53
	10: AM	90	63
	12: M	107	74
	2: PM	108	75
	4: PM	107	75
	6: PM	86	74
July 18	8: AM	56	51
	10: AM	90	62
	12: M	110	70
	2: PM	110	72
	4: PM	110	76
	6: PM	86	75
July 19	8: AM	60	58
	10: AM	102	67
	12: M	114	71
	2: PM	115	73
	4: PM	110	72
	6: PM	90	71
July 20	8: AM	70	56
	10: AM	84	65
	12: M	115	68
	2: PM	115	73
	4: PM	108	73
	6: PM	75	71

Date	Time of day	Temperature in degrees Fahr. (A) Seeds in sunlight	(B) Seeds in shade
July 21	8:AM	68	54
	10:AM	79	62
	12:M	97	64
	2:PM	102	67
	4:PM	102	67
	6:PM	70	67
July 22	8:AM	46	45
	10:AM	81	59
	12:M	112	68
	2:PM	118	73
	4:PM	102	77
	6:PM	85	68
July 23	8:AM	51	50
	10:AM	92	66
	12:M	112	72
	2:PM	119	77
	4:PM	111	80
	6:PM	85	77
July 24	8:AM	50	49
	10:AM	70	60
	12:M	106	66
	2:PM	112	72
	4:PM	108	75
	6:PM	88	74
July 25	8:AM	44	43
	10:AM	80	65
	12:M	110	71
	2:PM	118	888
	4:PM	112	80
	6:PM	86	72
July 26	8:AM	52	52
	10:AM	74	64
	12:M	112	72
	2:PM	120	78
	4:PM	120	80
	6:PM	100	84
July 27	8:AM	51	50
	10:AM	80	66
	12:M	102	64
	2:PM	122	80
	4:PM	116	85
	6:PM	98	84
July 28	8:AM	51	50
	10:AM	72	62
	12:M	110	72
	2:PM	122	80
	4:PM	114	83
	6:PM	96	80

Date	Time of day	Temperature in degrees Fahr. (A) Secs in sunlight	(B) Secs in shade
July 28	8: AM	50	51
	10: AM	72	62
	12: M	110	72
	2: PM	122	80
	4: PM	114	83
	6: PM	96	80
July 29	8: AM	46	50
	10: AM	70	62
	12: M	112	72
	2: PM	115	76
	4: PM	106	78
	6: PM	88	78
July 30	8: AM	42	48
	10: AM	68	58
	12: M	104	70
	2: PM	110	73
	4: PM	112	76
	6: PM	98	78
July 31	8: AM	48	50
	10: AM	80	62
	12: M	110	62
	2: PM	118	78
	4: PM	114	82
	6: PM	96	82
August 1	8: AM	48	50
	10: AM	78	60
	12: M	110	74
	2: PM	120	80
	4: PM	118	84
	6: PM	94	80
August 2	8: AM	50	52
	10: AM	70	64
	12: M	102	72
	2: PM	120	80
	4: PM	106	78
	6: PM	98	78
August 3	8: AM	50	50
	10: AM	80	66
	12: M	117	75
	2: PM	120	80
	4: PM	110	84
	6: PM	99	80
August 4	8: AM	62	56
	10: AM	86	66
	12: M	121	74
	2: PM	100*	80
	4: PM	85*	79
	6: PM	85*	79

* Cloudy.

Date	Time of Day	Temperature in degrees Fahr. (A) Secs in sunlight	(B) Secs in shade
August 5	8:AM	58	56
	10:AM	100	66
	12:M	110	71
	2:PM	112	78
	4:PM	118	80
	6:PM	82	77
August 6	8:AM	52	52
	10:AM	97	64
	12:M	112	74
	2:PM	119	79
	4:PM	110	82
	6:PM	82	80
August 7	8:AM	52	52
	10:AM	70	56
	12:M	92	72
	2:PM	122	84
	4:PM	110	88
	6:PM	106	90
August 8	8:AM	58	60
	10:AM	96	62
	12:M	110	74
	2:PM	118	76
	4:PM	108	80
	6:PM	80	76
August 9	8:AM	52	52
	10:AM	64	58
	12:M	86	64
	2:PM	95	70
	4:PM	90	74
	6:PM	88	76
August 10	8:AM	48	52
	10:AM	72	60
	12:M	98	74
	2:PM	121	82
	4:PM	122	86
	6:PM	92	90
August 12	8:AM	54	56
	10:AM	68	58
	12:M	96	72
	2:PM	121	86
	4:PM	116	92
	6:PM	100	82
August 13	8:AM	54	54
	10:AM	80	66
	12:M	120	84
	2:PM	126	92
	4:PM	120	96
	6:PM	100	84

Date	Time of day	Temperature in degrees Fahr. (A) Secs in sunlight	(B) Secs in shade
August 14	8:AM	64	60
	10:AM	96	74
	12:M	122	86
	2:PM	131	92
	4:PM	124	96
	6:PM	100	92
August 16	8:AM	68	60
	10:AM	103	74
	12:M	123	82
	2:PM	120	87
	4:PM	110	88
	6:PM	98	86

TEMPERATURE RECORDS OF BARK ON PROSTRATE LOGS AT JENNY CREEK CAMP, OREGON. PERIOD JULY 15 - AUGUST 16, 1920.

Longitude, 122 degrees, 20 min. West.
Latitude, 42 degrees, 5 min. North.
Elevation, 3,600 feet.

Date	Time of day	Temperature, degrees Fahr. (A) Log in sunlight	(B) Log in shade
July 15	8:AM	60	56
	10:AM	78	60
	12:M	90	64
	2:PM	90	68
	4:PM	88	70
	6:PM	82	70
July 16	8:AM	60	58
	10:AM	72	62
	12:M	90	69
	2:PM	88	70
	4:PM	80	70
	6:PM	80	68
July 17	8:AM	60	55
	10:AM	80	63
	12:M	92	66
	2:PM	91	67
	4:PM	89	71
	6:PM	83	71
July 18	8:AM	60	57
	10:AM	82	64
	12:M	92	68
	2:PM	92	70
	4:PM	90	71
	6:PM	82	69
July 19	8:AM	66	58
	10:AM	90	66
	12:M	98	68
	2:PM	97	70
	4:PM	90	70
	6:PM	82	70
July 20	8:AM	75	58
	10:AM	81	62
	12:M	94	67
	2:PM	94	70
	4:PM	89	70
	6:PM	81	68

Date	Time of day	Temperature in degrees Fahr. (A) Bark in sunlight	(B) Log in shade
July 21	8: AM	70	50
	10: AM	76	62
	12: M	84	64
	2: PM	82	64
	4: PM	80	65
	6: PM	78	65
July 22	8: AM	58	50
	10: AM	76	59
	12: M	95	65
	2: PM	95	69
	4: PM	92	70
	6: PM	87	72
July 23	8: AM	62	51
	10: AM	82	64
	12: M	94	68
	2: PM	102	70
	4: PM	87	74
	6: PM	86	74
July 24	8: AM	60	50
	10: AM	77	62
	12: M	95	68
	2: PM	100	70
	4: PM	92	72
	6: PM	88	71
July 25	8: AM	64	54
	10: AM	80	65
	12: M	96	68
	2: PM	102	72
	4: PM	94	70
	6: PM	87	66
July 26	8: AM	66	58
	10: AM	81	64
	12: M	98	70
	2: PM	106	74
	4: PM	104	76
	6: PM	98	78
July 27	8: AM	66	58
	10: AM	84	66
	12: M	98	62
	2: PM	110	76
	4: PM	102	78
	6: PM	96	80
July 28	8: AM	68	60
	10: AM	82	65
	12: M	100	72
	2: PM	108	76
	4: PM	100	78
	6: PM	94	78

Date	Time of day	Temperature in degrees Fahr. (A) Log in sunlight	(B) Log in shade
July 29	8: AM	66	58
	10: AM	82	64
	12: M	102	70
	2: PM	102	74
	4: PM	96	74
	6: PM	90	74
July 30	8: AM	60	56
	10: AM	78	60
	12: M	100	70
	2: PM	102	70
	4: PM	92	70
	6: PM	82	72
July 31	8: AM	62	54
	10: AM	80	62
	12: M	98	70
	2: PM	104	72
	4: PM	92	75
	6: PM	92	76
August 1	8: AM	60	50
	10: AM	80	62
	12: M	98	72
	2: PM	106	76
	4: PM	98	78
	6: PM	90	74
August 2	8: AM	66	60
	10: AM	80	66
	12: M	98	62
	2: PM	104	76
	4: PM	104	76
	6: PM	96	78
August 3	8: AM	64	58
	10: AM	86	66
	12: M	102	72
	2: PM	100	75
	4: PM	95	77
	6: PM	94	76
August 4	8: AM	72	60
	10: AM	83	68
	12: M	100	74
	2: PM	94	76
	4: PM	86	75
	6: PM	84	74
August 5	8: AM	70	62
	10: AM	82	67
	12: M	92	70
	2: PM	94	74
	4: PM	79	75
	6: PM	75	72

Date	Time of day	Temperature in degrees Fahr. (A) Log in sunlight	(B) Log inshade
August 6	8:AM	64	58
	10:AM	78	63
	12:M	96	70
	2:PM	98	74
	4:PM	89	75
	6:PM	88	76
August 7	8:AM	64	58
	10:AM	70	60
	12:M	90	70
	2:PM	105	76
	4:PM	100	80
	6:PM	98	82
August 8	8:AM	72	66
	10:AM	76	61
	12:M	94	68
	2:PM	96	72
	4:PM	88	73
	6:PM	85	70
August 9	8:AM	64	58
	10:AM	70	60
	12:M	82	66
	2:PM	90	70
	4:PM	85	72
	6:PM	84	73
August 11	8:AM	65	60
	10:AM	70	62
	12:M	90	72
	2:PM	100	77
	4:PM	102	80
	6:PM	90	82
August 12	8:AM	64	58
	10:AM	68	60
	12:M	88	70
	2:PM	100	80
	4:PM	100	84
	6:PM	94	84
August 13	8:AM	68	61
	10:AM	90	74
	12:M	100	84
	2:PM	104	84
	4:PM	100	87
	6:PM	98	87
August 14	8:AM	66	62
	10:AM	86	76
	12:M	100	84
	2:PM	106	90
	4:PM	98	90
	6:PM	96	88

Date	Time of day	Temperature in degrees Fahr. (A) Log in sunlight	(B) Log in shade
August 16:	8:AM	72	64
	10:AM	86	74
	12:M	98	81
	2:PM	100	84
	4:PM	94	84

RECORDS OF HUMIDITY AT JENNY CREEK CAMP, OREGON. PERIOD JULY 9 TO AUGUST 16, 1920.

Longitude 122 degrees, 20 minutes West.
Latitude 42 degrees, 5 minutes North.
Elevation 3600 feet.

Date	Time of day	Wet Bulb degrees	Dry Bulb degrees	Depression.	Rel. Hum. Percent	Dew Point degrees	Atmosphereric conditions
July 9	10:AM	58	76	18	31	43	Clear - dry
	1:PM	61	84	23	24	43	" "
	5:PM	60	81	21	26	43	" "
July 14	3:PM	58	72	14	42	47	" "
July 15	8:AM	53	68	15	34	39	" "
	10:AM	54	73	19	19	35	" "
	12:M	55	78	23	18	31	" "
	2:PM	57	76	19	28	41	" "
	4:PM	55	78	23	18	31	" "
	6:PM	53	76	23	16	27	" "
July 16	8:AM	54	70	16	33	39	" "
	10:AM	56	74	18	29	40	" "
	12:M	59	83	24	20	38	" "
	2:PM	56	77	21	23	36	" "
	4:PM	52	75	23	15	25	Cloudy
	6:PM	52	74	22	17	27	"
July 17	8:AM	54	68	14	38	42	Clear - dry
	10:AM	55	73	18	29	38	" "
	12:M	56	75	19	27	39	" "
	2:PM	56	78	22	21	35	" "
	4:PM	53	76	23	16	27	" "
	6:PM	52	75	23	15	25	" "

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Date	Time of day	Wet bulb degrees	Dry bulb degrees	Depression.	Rel. Hum. percent	Dew point degrees	Atmospheric conditions.
July 18	8:AM	55	67	22	45	7	Dry - Clear
	10:AM	53	70	17	29	36	" "
	12:M	60	84	24	21	40	" "
	2:PM	57	78	21	24	38	" "
	4:PM	56	77	21	22	36	" "
	6:PM	52	75	23	15	25	" "
July 19	8:AM	57	64	7	65	52	" "
	10:AM	57	72	15	38	45	" "
	12:M	58	71	13	45	48	" "
	2:PM	58	77	19	29	42	" "
	4:PM	56	79	23	19	34	" "
	6:PM	54	76	22	19	31	" "
July 20	8:AM	57	62	5	74	53	" "
	10:AM	57	68	11	50	49	" "
	12:M	56	72	16	34	42	" "
	2:PM	58	75	17	34	44	" "
	4:PM	57	73	16	35	44	" "
	6:PM	55	68	13	42	44	" "
July 21	8:AM	54	60	6	68	49	" "
	10:AM	56	64	8	60	50	" "
	12:M	56	67	15	49	47	" "
	2:PM	56	67	11	49	47	" "
	4:PM	55	67	12	45	45	" "
	6:PM	53	63	10	50	44	" "
July 22	8:AM	52	57	5	71	48	" "
	10:AM	54	67	13	41	43	" "
	12:M	55	75	20	24	36	" "
	2:PM	55	80	25	15	28	" "
	4:PM	59	84	25	19	37	" "
	6:PM	56	78	22	21	35	" "

Date	Time of day	Wet Bulb degrees	Dry Bulb degrees	Depression.	Rel. Hum. Percent	Dew Point degrees	Atmospheric conditions.
July 23	8:AM	50	55	5	70	45	Clear - Dry
	10:AM	66	74	8	65	62	" "
	12:M	60	84	24	21	40	" "
	2:PM	59	84	25	19	37	" "
	4:PM	61	82	21	28	45	" "
	6:PM	60	77	17	35	48	" "
July 24	8:AM	49	54	5	70	44	" "
	10:AM	58	68	10	54	51	" "
	12:M	68	76	8	66	64	" "
	2:PM	60	81	21	20	43	" "
	4:PM	60	78	18	33	46	" "
	6:PM	57	75	18	30	42	" "
July 25	8:AM	46	52	6	63	40	" "
	10:AM	56	74	18	29	40	" "
	12:M	57	81	24	18	34	" "
	2:PM	61	84	23	24	43	" "
	4:PM	59	83	24	20	38	" "
	6:PM	57	76	19	28	41	" "
July 26	8:AM	54	59	5	72	50	" "
	10:AM	60	77	17	17	48	" "
	12:M	59	82	23	22	39	" "
	2:PM	58	85	27	16	32	" "
	4:PM	58	81	23	20	38	" "
	6:PM	59	87	28	14	33	" "
July 27	8:AM	54	57	3	82	52	" "
	10:AM	59	73	14	10	49	" "
	12:M	58	81	23	20	38	" "
	2:PM	60	88	28	15	35	" "
	4:PM	58	90	32	13	32	" "
	6:PM	61	86	25	21	41	" "

Date	Time of day	Wet Bulb degrees	Dry Bulb degrees	Depression.	Rel. Hum. percent	Dew Point degrees	Atmospheric conditions
July 28	8:AM	50	53	3	81	47	Clear - Dry
	10:AM	55	74	19	26	37	" "
	12:M	56	82	26	14	29	" "
	2:PM	56	86	30	9	22	" "
	4:PM	57	87	30	9	25	" "
	6:PM	58	84	26	16	34	" "
July 29	8:AM	54	60	6	78	49	" "
	10:AM	56	72	16	3	42	" "
	12:M	58	80	22	23	39	" "
	2:PM	60	83	23	22	41	" "
	4:PM	58	78	20	27	41	" "
	6:PM	57	75	18	8	42	" "
July 30	8:AM	52	62	10	50	43	" "
	10:AM	54	70	16	33	48	" "
	12:M	56	78	22	21	35	" "
	2:PM	57	80	23	20	36	" "
	4:PM	58	78	20	27	41	" "
	6:PM	58	77	19	29	42	" "
July 31	8:AM	54	61	7	63	48	" "
	10:AM	58	74	16	36	45	" "
	12:M	58	80	22	23	39	" "
	2:PM	59	83	24	20	38	" "
	4:PM	60	83	23	22	41	" "
	6:PM	60	81	21	26	43	" "
August 1	8:AM	52	60	8	58	45	" "
	10:AM	58	74	16	36	45	" "
	12:M	59	84	25	19	37	" "
	2:PM	57	85	28	12	28	" "
	4:PM	60	82	22	25	42	" "
	6:PM	58	78	20	27	41	" "

Date	Time of day	Wet Bulb degrees	Dry Bulb degrees	Depression.	Rel. Hum. percent	Dew Point degrees	Atmospheric conditions.
August 2	8:AM	54	58	4	777	51	Clear - Dry
	10:AM	60	74	14	43	50	" "
	12:M	63	79	16	40	53	" "
	2:PM	64	83	19	33	52	" "
	4:PM	61	83	22	25	44	" "
	6:PM	59	78	19	30	44	" "
August 3	8:AM	55	61	6	68	50	" "
	10:AM	61	78	17	36	49	" "
	12:M	60	84	24	21	40	" "
	2:PM	60	84	24	21	40	" "
	4:PM	63	84	21	29	48	" "
	6:PM	60	80	20	29	44	" "
August 4	8:AM	63	74	11	54	56	" "
	10:AM	61	80	19	32	47	" "
	12:M	60	85	25	19	39	" "
	2:PM	59	82	23	22	39	Cloudy
	4:PM	59	77	18	32	45	"
	6:PM	58	70	12	12	49	Cloudy
August 5	8:AM	60	67	7	66	55	hazy
	10:AM	62	79	17	37	50	Clear - Dry
	12:M	68	78	10	60	63	" "
	2:PM	59	79	20	28	43	" "
	4:PM	60	80	20	29	44	" "
	6:PM	63	75	12	51	55	" "
August 6	8:AM	58	64	6	70	54	" "
	10:AM	57	72	15	38	45	" "
	12:M	62	81	19	30	49	" "
	2:PM	61	79	18	34	48	" "
	4:PM	61	82	21	28	45	" "
	6:PM	60	80	20	29	44	" "

Date	Time of day	Wet Bulb degrees	Dry Bulb degrees	Depression.	Rel. Hum. percent	Dew Point degrees	Atmospheric conditions
August 7	8:AM	56	63	7	64	51	Clear - Dry
	10:AM	54	61	7	63	48	" "
	12:M	62	85	23	24	45	" "
	2:PM	62	90	28	17	39	" "
	4:PM	64	94	30	16	41	" "
	6:PM	65	91	26	22	47	" "
August 8	8:AM	54	58	4	77	51	" "
	10:AM	57	72	15	38	45	" "
	12:M	62	81	19	32	49	" "
	2:PM	61	79	18	34	48	" "
	4:PM	61	82	21	28	45	" "
	6:PM	60	80	20	29	44	" "
August 9	8:AM	52	53	1	94	51	Foggy
	10:AM	58	65	7	66	53	Clear
	12:M	63	75	12	51	55	"
	2:PM	62	79	17	37	50	Intermittent Clds
	4:PM	64	80	16	41	54	Clear
	6:PM	62	80	18	35	50	"
August 11	8:AM	54	56	2	88	53	Clear - Dry
	10:AM	60	70	10	55	53	" "
	12:M	61	85	24	21	42	" "
	2:PM	62	90	28	17	39	" "
	4:PM	65	90	25	24	48	" "
	6:PM	63	88	25	22	45	" "
August 12	8:AM	52	54	2	88	50	" "
	10:AM	50	68	18	23	29	" "
	12:M	59	81	22	23	41	" "
	2:PM	64	95	31	18	43	" "
	4:PM	65	95	30	16	43	" "
	6:PM	63	94	31	18	41	" "

Date	Time of day	Wet Bulb degrees	Dry Bulb degrees	Depression.	Rel. Hum. percent	Dew Point degrees	Atmospheric conditions
August 13	8: AM	54	64	10	51	46	Clear - Dry
	10: AM	63	82	29	33	14	" "
	12: M	64	94	30	16	41	" "
	2: PM	65	94	29	18	44	" "
	4: PM	65	93	28	19	45	" "
	6: PM	63	92	29	17	40	" "
August 14	8: AM	60	69	9	59	54	" "
	10: AM	64	86	22	28	49	" "
	12: M	65	94	29	18	44	" "
	2: PM	65	96	31	18	45	" "
	4: PM	68	96	28	22	51	" "
	6: PM	66	91	25	29	50	" "
August 16	8: AM	60	70	10	55	53	" "
	10: AM	64	84	20	32	51	" "
	12: M	64	90	26	22	45	" "
	2: PM	60	87	27	16	36	" "
	4: PM	62	85	23	24	45	" "
	6: PM	60	80	20	29	44	" "

RECORDS OF SUNLIGHT INTENSITY OR SOLAR HEAT AT
JENNY CREEK CAMP, OREGON. PERIOD JULY 9 - Aug 16, 1920.

Longitude, 122 degrees, 20 min. North.
Latitude, 42 degrees, 5 min. North.
Elevation, 3,600 feet.

Date	Time of day	Black Bulb degrees	Clear Bulb degrees	Accelleration of Black Bulb.*
July 9	10:AM	114	102	12
	1:PM	116	110	6
	5:PM	106	98	8
July 14	3:PM	114	94	20
July 15	8:AM	98	88	10
	10:AM	104	96	8
	12:M	100	94	6
	2:PM	103	99	4
	4:PM	112	102	10
	6:PM	84	82	2
July 16	8:AM	100	90	10
	10:AM	115	102	13
	12:M	112	104	8
	2:PM	114	105	9
	4:PM	75	75	0
	6:PM	73	73	0
July 17	8:AM	98	90	8
	10:AM	102	94	8
	12:M	114	104	10
	2:PM	112	100	12
	4:PM	110	100	10
	6:PM	86	82	4
July 18	8:AM	98	92	6
	10:AM	100	92	8
	12:M	112	104	8
	2:PM	114	106	8
	4:PM	110	100	10
	6:PM	83	81	2
July 19	8:AM	102	91	11
	10:AM	112	100	12
	12:M	109	99	9
	2:PM	112	102	10
	4:PM	112	102	10
	6:PM	86	83	3

* Accelleration denotes the intensity of the sunlight or the amount of solar heat retained by the black bulb.

Date	Time of day	Black Bulb degrees	Clear Bulb degrees	Accelleration of Black Bulb *
July 20	8: AM	96	90	6
	10: AM	106	94	12
	12: M	110	103	7
	2: PM	110	102	8
	4: PM	87	83	4
	6: PM	86	81	5
July 21	8: AM	92	86	6
	10: AM	99	88	11
	12: M	88	82	6
	2: PM	102	90	12
	4: PM	100	90	10
	6: PM	89	82	7
July 22	8: AM	95	87	8
	10: AM	97	89	8
	12: M	111	101	10
	2: PM	114	104	10
	4: PM	98	92	6
	6: PM	95	90	5
July 23	8: AM	93	90	3
	10: AM	106	98	8
	12: M	95	90	5
	2: PM	112	106	6
	4: PM	94	90	4
	6: PM	80	75	5
July 24	8: AM	92	84	8
	10: AM	98	88	10
	12: M	104	96	8
	2: PM	112	102	10
	4: PM	96	88	8
	6: PM	98	92	6
July 25	8: AM	88	80	8
	10: AM	106	96	10
	12: M	110	102	8
	2: PM	114	110	4
	4: PM	112	104	8
	6: PM	100	96	4
July 26	8: AM	86	78	8
	10: AM	100	94	6
	12: M	110	100	10
	2: PM	119	112	7
	4: PM	112	108	4
	6: PM	108	104	4
July 27	8: AM	85	76	9
	10: AM	104	96	8
	12: M	114	106	8
	2: PM	121	112	9
	4: PM	119	112	7
	6: PM	112	106	6

Date	Time of day	Black Bulb degrees	Clear Bulb degrees	Accelleration of Black Bulb*	
July 28	8:AM	58	54	4	
	10:AM	110	100	10	
	12:M	112	108	4	
	2:PM	121	112	9	
	4:PM	122	116	6	
	6:PM	112	102	10	
July 29	8:AM	90	80	10	
	10:AM	108	96	12	
	12:M	110	100	10	
	2:PM	104	100	4	
	4:PM	110	102	8	
	6:PM	100	90	10	
July 30	8:AM	88	80	10	
	10:AM	102	90	12	
	12:M	108	100	8	
	2:PM	110	102	8	
	4:PM	110	102	8	
	6:PM	102	86	6	
July 31	8:AM	86	82	4	
	10:AM	98	92	6	
	12:M	106	96	10	
	2:PM	118	110	8	
	4:PM	114	106	8	
	6:PM	98	92	6	
Augudt 1	8:AM	86	80	6	
	10:AM	96	90	6	
	12:M	100	92	8	
	2:PM	112	104	8	
	4:PM	112	104	8	
	6:PM	96	90	6	
August 2	8:AM	76	70	6	
	10:AM	96	90	6	
	12:M	108	100	8	
	2:PM	116	108	8	
	4:PM	112	104	8	
	6:PM	100	98	2	
August 3	8:AM	90	85	5	
	10:AM	110	101	9	
	12:M	114	92	22	
	2:PM	114	104	10	
	4:PM	107	98	9	
	6:PM	104	98	6	
August 4	8:AM	96	88	8	
	10:AM	106	98	8	
	12:M	106	100	6	
	2:PM	84	84	0	Cloudy
	4:PM	80	80	0	"
	6:PM	76	76	0	"

Date	Time of day	Black Bulb degrees	Clear Bulb degrees	Accelleration of Black Bulb*	
August 5	9: AM	94	86	8	Hazy
	10: AM	109	102	7	
	12: M	102	96	6	
	2: PM	112	103	9	
	4: PM	93	87	6	
	6: PM	83	79	4	
August 6	8: AM	100	93	7	
	10: AM	103	95	8	
	12: M	109	100	9	
	2: PM	110	100	10	
	4: PM	105	99	6	
	6: PM	94	88	6	
August 7	8: AM	90	80	10	
	10: AM	98	82	16	
	12: M	110	100	10	
	2: PM	122	110	12	
	4: PM	120	112	8	
	6: PM	110	104	6	
August 8	8: AM	68	64	4	
	10: AM	103	95	8	
	12: M	110	100	10	
	2: PM	114	104	10	
	4: PM	118	109	9	
	6: PM	100	92	8	
August 9	8: AM	54	54	0	Foggy
	10: AM	86	80	6	
	12: M	92	86	6	
	2: PM	100	94	6	Hazy
	4: PM	100	94	6	
	6: PM	98	92	6	
August 10	8: AM	70	64	6	
	10: AM	90	80	10	
	12: M	110	100	10	
	2: PM	120	114	6	
	4: PM	120	114	6	
	6: PM	90	86	4	
August 12	8: AM	68	60	8	
	10: AM	83	70	18	
	12: M	108	96	12	
	2: PM	120	108	12	
	4: PM	120	114	6	
	6: PM	110	104	6	
August 13	8: AM	72	66	6	
	10: AM	104	96	8	
	12: M	118	110	8	
	2: PM	122	114	8	
	4: PM	118	112	6	
	6: PM	100	96	4	

Date	Time of day	Black Bulb degrees	Clear Bulb degrees	Accelleration of Black Bulb*
August 14	8:AM	90	82	8
	10:AM	112	104	8
	12:M	119	111	8
	2:PM	129	118	11
	4:PM	124	116	8
	6:PM	100	92	8
August 15	8:AM	92	86	6
	10:AM	112	102	10
	12:M	118	110	8
	2:PM	112	104	8
	4:PM	96	90	6

Thermograph Record- Solar Heat
Experiment: July 9 to Aug 18, 1920.
Form No. 1072—Met'l.
Long: 122:20 W. Lat: 42:5 N. El 3,600

Friday July 9 | Sat July 10th | Sunday July 11 | Monday July 12 | Tuesday July 13 | Wednesday July 14 | Thursday July 15 | Fri July 16

6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10

90
80
70
60
50
40
30
20
10

Thermograph Record- Solar Heat
Experiment: July 9 to Aug 18, 1920.
Form No. 1072—Met'l.
Long: 122:20 W. Lat 42:5 N. El 3,600

Fri July 16 | Sat July 17 | Sunday July 18 | Monday July 19 | Tuesday July 20 | Wednesday July 21 | Thurs July 22 | Fri July 23

6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10

90
80
70
60
50
40
30
20
10

Thermograph Record- Solar Heat
Experiment: July 9 to Aug 18, 1920.
Form No. 1072—Met'l.
Long: 122:20 W. Lat: 42:5 N. El 3,600

Fri July 23 | Sat July 24 | Sund July 25 | Monday July 26 | Tues July 27 | Wed July 28 | Thurs July 29 | Fri July 30

6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10

90 80 70 60 50 40 30 20 10

Thermograph Record- Solar Heat
Experiment: July 9 to Aug 18, 1920
Form No. 1072—Met'l.
Long: 122:20 W. Lat: 42:5 N. El 3,600

Fri July 30 | Sat July 31 | Sund Aug 1 | Mond Aug 2 | Tues Aug 3 | Wed Aug 4 | Thurs Aug 5 | Fri Aug 6

6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10

90 80 70 60 50 40 30 20 10

Thermograph Record- Solar Heat
Experiment: July 9 to Aug 18, 1920.
Form No. 1072-Met'l.
Long: 122:20 W. Lat: 42:5 N. El 3,600

Frid Aug 6 | Sat Aug 7 | Sund Aug 8 | Mond Aug 9 | Tues Aug 10 | Wed Aug 11 | Thurs Aug 12 | Frid Aug 13

6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10

90 80 70 60 50 40 30 20 10

Thermograph Record- Solar Heat
Experiment: July 9 to Aug 18, 1920.
Form No. 1072-Met'l.
Long: 122:20 W. Lat: 42:5 N. El 3,600

Frid Aug 13 | Sat Aug 14 | Sund Aug 15 | Mond Aug 16 | Tues Aug 17 | Wed Aug 18

6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10 XII 2 4 6 8 10 M 2 4 6 8 10

90 80 70 60 50 40 30 20 10

EXPERIMENT 5b -

Proceedure:

Yellow pine bark infested with Dendroctonus brevicomis was removed from standing tree No. D13, Jenny Creek Unit, on August 3, and placed in cabin near where experiment was conducted. This bark contained a virile brood of the beetle in full grown larvae, pupae, and new adult stages.

The bark was exposed in the same way as was the bark under experiment 5a with the exception only in the duration of the exposure. In this test the following technique was provided for: Beginning the first day, August 4 at 8:00 AM, one section of bark was placed in position of exposure to direct sunlight. After two hours exposure it was removed and another unexposed section was exposed in the same position and after exposure was likewise removed. This was continued for four days, the only deviation being in the duration of the exposure allowed the individual sections. Bark and air temperature records were taken when each section was placed for exposure and also when the section was removed.

Time, date, and duration of exposure and temperature of each bark section exposed is given in the following table.

Footnotes to table:

* Bark temperatures obtained from readings of stirring rod themometer inbedded in the bark.

** Air temperature records obtained from standard Taylor thermometer attached to northe side of yellow pine tree near place of exposure.

*** Percent of relative humidity from psychrometer tests made when sections were removed.

EXPERIMENT 5b - EXPOSURE OF BARK.

Date	Time of day	Duration of exposure	Bark section No.	Bark temperature* When placed	Bark temperature* When removed	Air temperature** When palced	Air temperature** When removed	Percent of relative humidity***
Aug 4	8:AM to 10:AM	2 hours	5b1	56	86	72	94	32
"	10:AM to 12:M	2 hours	5b2	86	121	94	96	19
"	12:M to 2:PM	2 hours	5b3	121	100	96	85	22
"	2:PM to 4:PM	2 hours	5b4	100	85	85	84	32
Aug 5	9:AM to 10:AM	1 hour	5b5	62	100	77	84	37
"	10:AM to 11:AM	1 hour	5b6	100	106	84	86	55
"	12:M to 1:PM	1 hour	5b7	110	117	87	83	55
"	1:PM to 2:PM	1 hour	5b8	117	112	83	83	28
"	2:PM to 3:PM	1 hour	5b9	112	118	83	84	24
"	3:PM to 4:PM	1 hour	5b10	118	118	84	82	20
"	4:PM to 5:PM	1 hour	5b11	118	98	82	78	45
Aug 6	8:AM to 9:AM	1 hour	5b12	52	88	77	80	50
"	9:AM to 10:AM	1 hour	5b13	88	97	80	82	38
"	10:AM to 11:AM	1 hour	5b14	97	111	82	82	36
"	11:AM to 12:AM	1 hour	5b15	111	112	82	85	30
"	12: to 12:30PM	30 min.	5b16	112	118	85	84	32
"	12:30 to 1:PM	30 min.	5b17	118	118	84	82	34
"	1: to 1:30PM	30 Min.	5b18	118	119	82	81	34
"	2: to 2:30PM	30 min.	5b19	119	118	82	82	30
"	2:30 to 3:PM	30 min.	5b20	118	120	82	83	28
Aug 11	11:30 to 11:45A	15 min.	5b21	96	100	97	95	24
"	11:45 to 12:M	15 min.	5b22	100	108	97	99	21
"	12: to 12:20PM	20 min.	5b23	108	114	99	96	20
"	12:20 to 12:50PM	30 min.	5b24	114	120	96	94	19
"	12:50 to 1:30PM	40 Min.	5b25	120	120	94	92	18
"	1:30 to 2:20PM	50 min.	5b26	120	122	92	93	17

EXPERIMENT NO. 5b - RESULT OF CUTTING TEST AND ANALYSIS OF BARK SUBJECTED TO SOLAR HEAT.

Bark section number	Surface square inches	No. of entrance holes	No. of ventilation holes	No. of exit holes	Dead brood: Number of larvae	Dead brood: Number of pupae	Dead brood: Number of new adults	Number of Clerid larvae: alive	Number of Clerid larvae: dead	When examined
5b1	100	3	4	80	8	1	1	1	1	Sept 9
5b2	72	2	9	7	62	46	100	0	0	"
5b3	55	2	6	8	30	11	135	0	0	"
5b4	45	2	7	43	2	0	5	2	0	Sept 10
5b5	54	2	33	16	14	12	47	1	0	"
5b6	48	3	11	32	0	0	16	1	0	Sept 12
5b7	54	2	12	13	6	12	33	0	0	"
5b8	54	6	8	19	16	27	48	2	0	"
5b9	70	2	34	1	24	18	123	1	0	"
5b10	60	2	18	9	12	21	42	0	2	Sept 20
5b11	42	2	21	17	3	3	6	0	1	"
5b12	45	1	17	25	5	4	6	0	0	"
5b13	36	1	20	17	2	6	9	1	0	"
5b14	63	2	22	19	11	23	60	0	0	"
5b15	54	1	32	8	9	30	36	1	0	"
5b16	44	2	17	22	12	12	60	0	1	Sept 21
5b17	40	1	19	16	7	13	15	0	0	"
5b18	45	1	18	4	15	20	35	2	0	"
5b19	60	2	22	8	10	22	40	1	0	"
5b20	40	0	14	3	5	7	19	1	1	"
5b21	63	1	20	29	2	3	2	0	0	"
5b22	60	2	18	38	3	2	0	0	0	Sept 22
5b23	60	1	17	30	4	1	0	0	0	"
5b24	40	1	13	20	6	5	2	0	0	"
5b25	84	3	27	42	11	7	4	0	0	"
5b26	77	2	21	3	24	17	31	1	0	"

EXPERIMENT 5b - Preliminary Examination of Exposed Bark.

Bark section No.	When examined:	Condition of brood - Result of exposure
5b1	Aug 4	Larvae, pupae and new adults alive-none dead
5b2	"	All larvae, pupae and new adults appear dead
5b3	"	" " " " " " " "
5b4	"	" " " " " " " alive
5b5	Aug 5	" " " " " " " dead
5b6	"	Some appear alive; sime dead
5b7	"	All appear to be dead
5b8	"	" " " " "
5b9	"	" " " " "
5b10	"	" " " " "
5b11	"	" " " " alive
5b12	Aug 6	" " " " "
5b13	"	" " " " "
5b14	"	" " " " dead
5b15	"	" " " " "
5b16	"	" " " " "
5b17	"	" " " " alive
5b18	"	" " " " dead
5b19	"	" " " " "
5b20	"	" " " " "
5b21	Aug 11	" " " " alive
5b22	"	" " " " "
5b23	"	" " " " "
5b24	"	" " " " "
5b25	"	Some appear to be dead; some alive
5b26	"	All appear to be dead

Note: This preliminary examination was made at the time the bark sections were removed from exposure: The sections were then tagged and put in the cabin to note possible recovery and further development of the brood: A cutting test and careful analysis of the sections were made after September 1 allowing ample time for the uninjured individuals to complete their development and emerge.

EXPERIMENT 5b - ANALYSIS.

Bark section number	Time of day of exposure	Duration of exposure	Bark temperature: When placed degrees Fahr.	Bark temperature: When removed degrees Fahr.	Percent of relative humidity	Mortality: No. of individuals & % of brood uninjured. No.	%	Mortality: No. of individuals & % of brood killed. No.	%	Effects of temperatures reached in the bark section
5b1	8:A to 10A	2hours	56	86	32	80	88 %	10	12%	Safe
5b2	10:A to 12M	2 hours	86	121	19	7	4 %	208	96%	Fatal
5b3	12M to 2PM	2 hours	121	100	22	8	4 %	176	96%	Fatal
5b4	2:PM to 4PM	2 hours	100	85	32	43	85 %	7	15%	Safe
5b5	9:A to 10:A	1 hour	62	100	37	16	18 %	73	82%	Critical
5b6	10:A to 11A	1 hour	100	106	55	32	67 %	16	33%	Critical
5b7	11:A to 12:M:	1 hour	106	117	55	13	20 %	51	80%	Critical
5b8	1:P to 2:PM:	1 hour	117	112	28	19	11%	110	89%	Critical
5b9	2:PM to 3:PM:	1 hour	112	118	24	1	.6%	165	99.4%	Fatal
5b10	3:PM to 4:PM:	1 hour	118	118	20	9	11%	75	89%	Critical
5b11	4:PM to 5:PM:	1 hour	118	98	45	17	60%	12	40%	Safe
5b12	8:A to 9:AM	1 hour	52	88	50	25	62.5%	15	37.5%	Safe
5b13	9:A to 10:AM:	1 hour	88	97	38	17	50%	17	50%	Safe
5b14	10:A to 11:A:	1 hour	97	111	36	19	15%	104	85	Critical
5b15	11:A to 12:A:	1 hour	111	112	30	8	11%	75	89%	Critical
5b16	12: to 12:30:	30 min.	112	118	32	22	12%	84	88%	Critical
5b17	12:30 to 1:P:	30 min.	118	118	34	16	32%	35	68%	Critical
5b18	1: to 1:30PM:	30 min.	118	119	34	4	5.5%	68	94.5%	Fatal
5b19	2:to 2:30PM	30 min.	119	118	30	8	10%	72	90%	Critical
5b20	2:30 to 3:PM:	30 min.	118	120	28	3	9%	31	91%	Critical
5b21	11:30 to11:45	15 min.	96	100	22	29	81%	7	19%	Safe
5b22	11:45to12:M	15 min.	100	108	21	38	88%	5	12%	Safe
5b23	12:to 12:20P:	20 min.	108	114	20	30	86%	4	14%	Safe
5b24	12:20to12:50:	30 min.	114	120	19	20	61%	13	29%	Safe
5b25	12:50to1:30P:	40 min.	120	120	18	42	64%	22	36%	Safe
5b26	1:30 to2:20P:	50 min.	120	122	17	3	4%	72	96%	Fatal

EXPERIMENT 5b - INDICATED MORTALITY OF BROODS IN BARK EXPOSED IN THIS EXPERIMENT TEST.

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Average hourly bark temperature for August 4 - 5 - 6 - 11

	AM				PM			
Time of day	8 to 9	9 to 10	10 to 11	11 to 12	12 to 1	1 to 2	2 to 3	3 to 4
Average bark temperature	53 - 75	75 - 94	94 - 103	103 - 114	114 - 118	118 - 113	113 - 114	114 - 106

Time and duration of allowed bark sections exposure

- 15 min. Safe
- 15 min. Safe
- 20 min. Safe
- 30 min. Safe to critical
- 60 min. Safe
- 40 min. Critical to fatal
- 60 min. Safe to critical
- 50 min. Fatal
- Critical
- 60 min.
- 30 min. Critical
- 60 min. Critical
- 30 min. Critical
- 30 min. Critical
- 120 Min. Safe to critical
- 60 min. Critical to fatal
- 120 min. Fatal
- 60 min. Crit to fatal
- 120 min. Fatal
- 60 min. Critical
- 120 min. Critical

EXPERIMENT 5b:

Object:

The object of this test was to determine the effects on a normal brood from exposures to direct sunlight at different periods throughout the day and to determine the time and duration of the daily period when the safe, critical, and fatal temperatures prevailed. To determine the minimum exposure fatal to the broods the length of exposure allowed the separate sections was also changed for each of the four days of the test.

Results:

Bark temperatures below 90 degrees were not sufficient to appreciably affect the mortality of the broods.

Critical temperatures ranged between 100 and 115 degrees; 40 to 90 percent of the broods were killed in this ranges of temperatures.(these percentages were incident to the duration of the exposures).

Temperatures above 120 degrees were approximately 100 percent fatal.

Safe temperatures prevailed before 10:AM and after 4:PM. During these periods the maximum bark temperatures did not exceed 100 degrees.

Critical temperatures (100 to 115 degrees) prevailed during the periods from 10:AM to 11:AM and from 3:PM to 4:PM.

Fatal temperatures, above 115 degrees, occurred only during the periods from 11:AM to 3:PM/

The minimum duration of exposure 95 percent or more fatal to the broods was 30 minutes.

EXPERIMENT 5c -

Proceedure:

Yellow pine bark infested with Dendroctonus brevicomis was removed from trap tree No. D1, Jenny Creek Unit, on August 13, and was placed to exposure.

This bark contained a virile brood of the beetle in full grown larvae, pupae, and new adult stages.

The bark was exposed to direct sunlight in like manner as 5a and 5b, with the exception of duration of exposure. The following technique was provided for: Seven section of bark were selected. The first day at 12:M, when the bark temperature approached 120 degrees, all seven sections were placed to exposure so that each section would receive the same degree of solar heat at initial expsoure. At progressive intervals one section was removed and stored for future examination and analysis. The first section was removed at 12:15 PM, just 15 minutes after it had been placed to exposure; the second section was removed at 12:30 PM, receiving 30 minutes exposure or twice that of the first: The third section was removed at 12:45 PM receiving three times the exposure of the first. This was continued until the seventh and last section was removed at 3:PM, receiving 180 minutes or twelve times the exposure of section one.

Details of the exposure given this experiment are shown in the following table.

EXPERIMENT 5c - EXPOSURE OF BARK.

Date	Time of day	Duration of exposure	Bark section number	Bark temperature: When placed	Bark temperature: When removed	Air temperature: When placed	Air temperature: When removed	Percent of relative humidity
Aug 13	12:M to 12:15	15 min.	5c1	120	120	99	99	16
	12:M to 12:30	30 min.	5c2	120	122	99	98	16
	12:M to 12:45	45 min.	5c3	120	125	99	99	16
	12:M to 1:00	60 min.	5c4	120	125	99	99	16
	12:M to 1:30	90 min.	5c5	120	127	99	100	17
	12:M to 2:00	120 min.	5c6	120	126	99	101	18
	12:M to 3:00	180 min.	5c7	120	126	99	103	19

EXPERIMENT NO. 5c - RESULT OF CUTTING TEST AND ANALYSIS OF BARK SUBJECTED TO SOLAR HEAT.

Bark section number	Surface squrae inches	No. of entrance holes	No. of ventilation holes	No. of exit holes	Dead brood: Number of larvae	Dead brood: Number of pupae	Dead brood: Number of new adult	Number of Clerid larvae: alive	Number of Clerid larvae: dead	Date when examined
5c1	60	2	18	51	2	1	2	0	0	Sept 23
5c2	60	1	20	22	8	5	0	0	0	"
5c3	60	3	25	16	8	11	7	1	0	"
5c4	112	4	38	18	21	36	47	0	1	"
5c5	77	4	38	1	18	33	40	0	0	"
5c6	90	3	41	4	22	27	51	1	2	Sept 24
5c7	86	2	26	0	20	16	72	0	0	"

EXPERIMENT 5c - ANALYSIS.

Bark section number	Time of day of exposure	Duration of exposure	Bark temperature When placed degrees Fahr.	Bark temperature When removed degrees Fahr.	Percent of relative humidity	Mortality No. of individuals & % of brood uninjured		Mortality No. of individuals & % of brood killed		Effects on brood by temperatures reached in the bark sections
						No.	%	NO.	%	
5c1	12:Mto12:15:	15 min.	120	120	16	51	91%	5	9%	Safe
5c2	12:M -12:30:	30 min.	120	122	16	22	63%	13	27%	Safe
5c3	12:M -12:45:	45 Min.	120	123	16	16	28%	26	62%	Critical
5c4	12:M - 1:P :	60 min.	120	125	16	18	15%	104	85%	Critical
5c5	12:M - 1:30:	90 min.	120	127	17	1	1%	91	99%	Fatal
5c6	12:M - 2: :	120 min.	120	128	18	4	4%	100	96%	Fatal
5c7	12:M - 3:PM:	180 min.	120	128	19	0		108	100%	Fatal

EXPERIMENT 5c - MORTALITY OF BROODS IN BARK SECTIONS SUBJECTED TO EXPOSURES OF DIFFERENT DURATIONS.

Time of day	12:M to 1:PM	1:PM to 2:PM	2:PM to 3:PM
Bark temperature	120 - 125	125 - 128	128 - 128
	Time and duration of exposures		
120 to 120 deg	15 min. Safe - 9% mortality		
120 to 122 deg	30 min. Safe - 27% mortality		
120 to 123 deg	45 min. Critical - 62% mortality		
120 to 125 deg	60 min. Critical - 85% mortality		
120 to 127 deg	90 min. Fatal 99% mort.		
120 to 128 deg	120 min. Fatal 96% mortality		
120 to 128 deg	180 min. Fatal - 100% mortality		

EXPERIMENT 5c -

Object:

The object of the test was to determine the minimum duration of exposure fatal to the broods at a high or supposed critical temperature.

Results:

The minimum duration of exposure necessary to produce 99 percent mortality was 90 minutes. The range of bark temperatures during this period was from 120 to 127 degrees.

Critical temperatures (120 to 123 degrees) were attained with a minimum exposure of 45 minutes.

Exposures of less than 45 minutes resulted in from 9 to 27 percent mortality only.

The bark temperatures did not rise above 123 degrees until after the bark had been exposed for over 45 minutes although exposure was begun at a bark temperature of 120 degrees.

Absolute or 100 percent mortality did not occur until the bark had been exposed for 180 minutes at bark temperatures ranging from 120 to 128 degrees.

EXPERIMENT 5d -

Proceedure:

Yellow pine bark infested with Dendroctonus brevicomis was removed from trap tree No. D1, Jenny Creek Unit, on August 14, and was placed to exposure. The bark contained a brood of the beetle in full grown larvae, pupae, and new adult stages.

This bark was exposed to direct sunlight in the usual manner with the following technique: Seven sections were selected and allowed to reach a relatively high temperature before the test was started. The test was started at 9:AM with all seven sections in exposure. The sections were removed one at atime at an interval of 60 minutes from the preceeding section. The first section was removed at 10:AM receiving 60 minutes exposure and the seventh and last section was removed at 4:PM receiving 420 minutes exposure.

Details appear in the following table:

EXPERIMENT 5d - EXPOSURE OF BARK.

Date	Time of day	Duration of exposure	Bark section number	Bark temperature When placed	Bark temperature When removed	Air temperature When Placed	Air temperature When removed	Percent of relative humidity
Aug 14	9:AM to 10:AM	60 min.	5d1	94	96	82	99	28
	9:AM to 11:AM	120 Min.	5d2	94	114	82	104	22
	9:AM to 12:M	180 min.	5d3	94	122	82	100	18
	9:AM to 1:PM	240 min.	5d4	94	125	82	100	18
	9:AM to 2:PM	300 min.	5d5	94	131	82	102	18
	9:AM to 3:PM	360 min.	5d6	94	129	82	101	20
	9:AM to 4:PM	420 min.	5d7	94	124	82	97	22

EXPERIMENT NO. 5d - CUTTING TEST AND ANALYSIS OF BARK SUBJECTED TO SOLAR HEAT.

Bark section number	Surface square inches	No. of entrance holes	No. of ventilation holes	No. of exit holes	Dead brood: Number of larvae	Dead brood: Number of pupae	Dead brood: Number of new adult	Number of Cleridae larvae: alive	Number of Cleridae larvae: dead	Date when examined
5d1	72	2	20	62	4	0	1	0	0	Sept 24
5d2	84	3	33	35	10	15	21	0	0	"
5d3	77	2	27	0	24	38	46	0	0	Sept 25
5d4	126	8	43	0	45	58	70	2	1	"
5d5	72	2	21	0	24	42	21	0	1	"
5d6	84	3	29	0	18	24	48	0	2	"
5d7	84	2	33	0	20	42	47	0	1	"

EXPERIMENT 5d - ANALYSIS.

Bark section number	Time of day of exposure	Duration of exposure	Bark temperatures When placed: degrees Fahr.	Bark temperatures When removed: degrees Fahr.	Percent of relative humidity	No. of individuals & % of brood uninjured. No.	No. of individuals & % of brood uninjured. %	No. of individuals & % of brood killed No.	No. of individuals & % of brood killed %	Effects on brood by temperatures reached in bark sections
5d1	9:AM to 10:A:	60 min.	94	96	28	62	93%	5	7%	Safe
5d2	9:AM to 11:A:	120 min.	94	114	22	35	43%	46	57%	Safe
5d3	9:AM to 12:M:	180 min.	94	122	18	0		108	100%	Fatal
5d4	9:AM to 1:PM:	240 min.	94	125	18	0		173	100%	Fatal
5d5	9:AM to 2:PM:	300 min.	94	131	18	0		87	100%	Fatal
5d6	9:AM to 3:PM:	360 min.	94	129	20	0		90	100%	Fatal
5d7	9:AM to 4:PM:	420 min.	94	124	22	0		109	100%	Fatal

EXPERIMENT 5d - MORTALITY OF BROODS IN BARK SUBJECTED TO RELATIVELY HIGH OR CRITICAL TEMPERATURES AT BEGINNING OF TEST.

Time of day	9:A to 10:A	10:A to 11:A	11:A to 12:M	12M to 1P	1P to 2P	2P to 3P	3P to 4P
Bark temperatures	94 - 96	96 - 114	114 - 122	122 - 125	125 - 131	131 - 129	129 - 124
	Time and duration of exposures						
94 to 96 degrees	60 min. 7% mortality						
94 to 114 degrees	120 min. 57% mortality						
94 to 122 degrees	180 min. 100% mortality						
94 to 125 degrees	240 min. 100% mortality						
94 to 131 degrees	300 min. 100% mortality						
94 to 131 degrees	360 min. 100% mortality						
94 to 131 degrees	420 min. 100% mortality						

EXPERIMENT 5d -

Object:

The object of the test was to determine the duration of exposure necessary to kill the broods when exposure is begin at a relatively high or critical temperature. It was also expected that it would indicate the effect on the broods, in some sections, by prolonged exposure at these temperatures.

Results:

High mortality did not occur until after the bark temperature had exceeded 114 degrees.

120 minutes exposure at temperatures ranging between 94 and 114 degrees produced only 57 percent mortality.

In section 5d3 100 percent mortality occurred with an exposure of 60 minutes when the bark temperatures ranged between 114 and 122 degrees.

The results of this test are of value only in showing that bark temperatures below 115 degrees do not produce a sufficiently high mortality to be practicable.

EXPERIMENT 5e -

Proceedure:

Yellow pine bark infested with Dendroctonus brevicomis was removed from trap tree No. D1, Jenny Creek Unit, on August 16, and was placed to exposure. The bark contained a brood of the beetle in full grown larvae, pupae, and new adult stages.

This bark was exposed to direct sunlight in the usual manner with the following technique: Seven sections were selected and while the bark temperature was relatively low were placed to exposure. The sections were removed one at a time at intervals of one hour. The first section received one hours exposure; the second section two hours exposure and so on until the seventh and last section had received seven hours exposure.

The following table presents the details of the exposure.

EXPERIMENT 5e - EXPOSURE OF BARK.

Date	Time of day	Duration of exposure	Bark section number	Bark temperature		Air temperature		Percent of relative humidity
				When placed	When removed	When placed	When removed	
Aug 16	9:AM to 10:AM	1 hour	5e1	68	103	94	95	32
	9:AM to 11:AM	2 hours	5e2	68	118	94	96	26
	9:AM to 12:M	3 hours	5e3	68	123	94	100	22
	9:AM to 1:PM	4 hours	5e4	68	126	94	101	20
	9:AM to 2:PM	5 hours	5e5	68	120	94	99	16
	9:AM to 3:PM	6 hours	5e6	68	110	94	90	10
	9:AM to 4:PM	7 hours	5e7	68	100	94	85	24

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EXPERIMENT NO. 5e - CUTTING TEST AND ANALYSIS OF BARK SUBJECTED TO SOLAR HEAT.

Bark section number	Surface square inches	No. of entrance holes	No. of ventilation holes	No. of exit holes	Dead Brood: Number of larvae	Dead Brood: Number of pupae	Dead Brood: Number of new adults	Number of Clerid larvae: alive	Number of Clerid larvae: dead	Date when examined
5e1	77	4	32	60	6	7	1	2	0	Sept 26
5e2	77	5	29	4	7	12	27	2	0	"
5e3	80	5	22	0	8	11	21	1	0	"
5e4	84	2	21	0	32	78	68	2	1	"
5e5	88	5	23	0	42	15	7	0	1	Sept 27
5e6	77	1	19	0	20	15	11	0	1	"
5e7	88	2	28	0	11	17	22	0	1	"

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EXPERIMENT 5e - ANALYSIS.

Bark section number	Time of day of exposure	Duration of exposure	Bark temperatures When placed degrees Fahr.	Bark temperatures When removed degrees Fahr.	Percent of relative humidity	No. of individuals & % of brood uninjured: No.	No. of individuals & % of brood uninjured: %	No. of individuals & % of brood killed: No.	No. of individuals & % of brood killed: %	Effects on brood by temperatures reached in bark sections
5e1	9:AM to 10::	1 hour	68	103	32	60	81%	14	19%	Safe
5e2	9:AM to 11::	2 hours	68	118	26	4	8%	46	92%	Critical
5e3	9:AM to 12::	3 hours	68	123	22	0		40	100%	Fatal
5e4	9:AM to 1:P:	4 hours	68	126	20	0		178	100%	Fatal
5e5	9:AM to 2:P:	5 hours	68	120	16	0		64	100%	Fatal
5e6	9:AM to 3:P:	6 hours	68	118	18	0		46	100%	Fatal
5e7	9:AM to 4:P:	7 hours	68	100	24	0		50	100%	Fatal

EXPERIMENT 5e - MORTALITY OF BROODS IN BARK SUBJECTED TO RELATIVELY LOW OR SAFE TEMPERATURES AT BEGINNING OF EXPOSURE.

Time of day	9A to 10A	10A to 11A	11A to 12A	12M to 1P	1P to 2P	2P to 3P	3P to 4P
Bark temperatures	68 - 103	103 - 118	118 - 123	123 - 126	126 - 120	120 - 118	118 - 100
	Time and duration of exposures						
68 to 103 degrees	1 hour; 19% mortality						
68 to 118 degrees		2 hours; 92% mortality					
68 to 123 degrees			3 hours; 100% mortality				
68 to 126 degrees				4 hours; 100% mortality			
68 to 126 degrees					5 hours; 100% mortality		
68 to 126 degrees					6 hours; 100% mortality		
68 to 126 degrees					7 hours; 100% mortality		

EXPERIMENT 5e -

Object:

The object of this test was to determine the duration of exposure necessary to kill the broods when exposure is begin at a relatively low temperature. Also the effects of prolonged exposure at the temperatures reached.

Results:

Analogous to Exp. 5d in results. Two hours exposure at temperatures ranging between 68 and 118 degrees produced only 92 percent mortality. After temperature had increased above 118 degrees 100 percent mortality occurred with one hour exposure.

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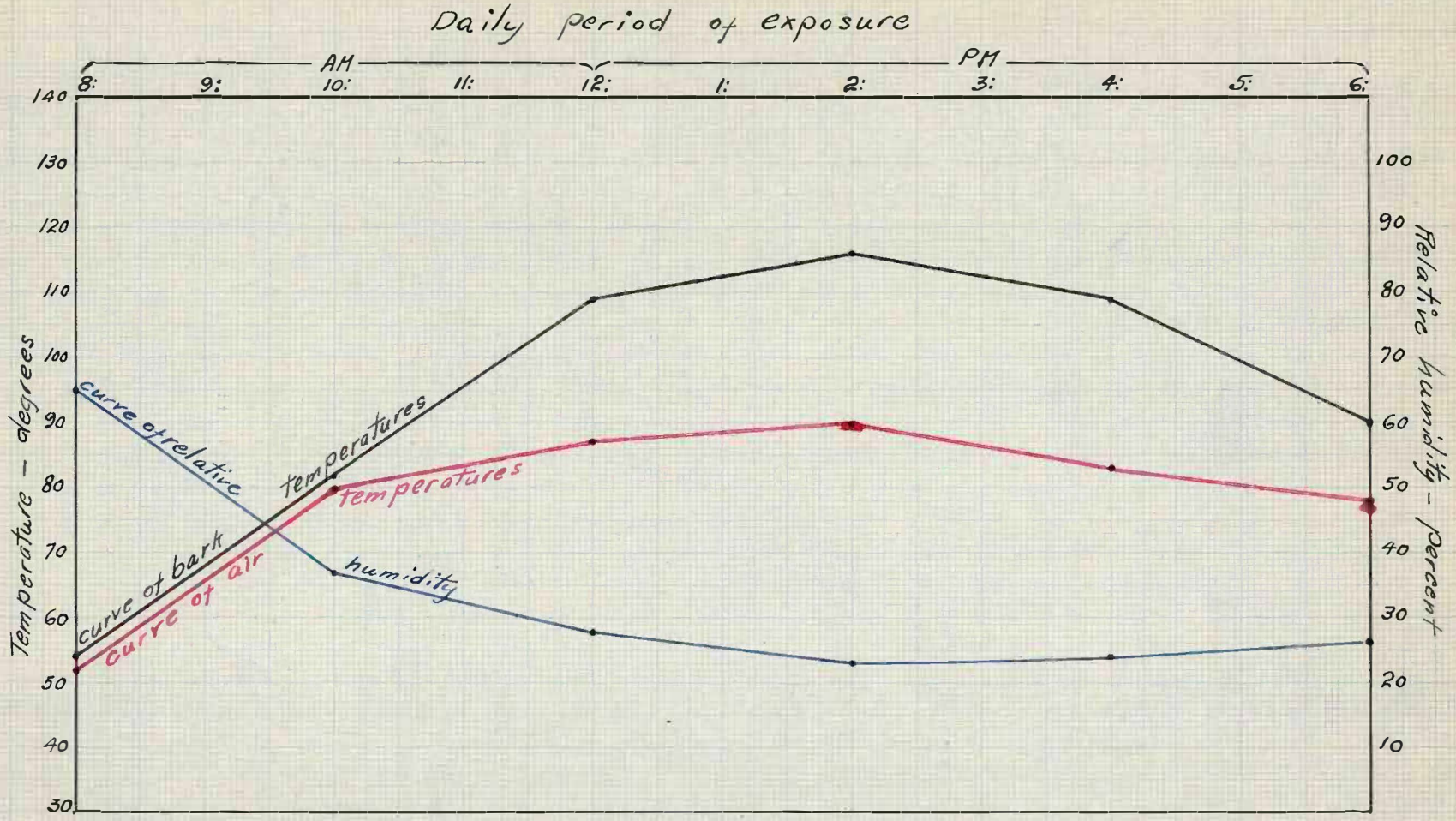

EXPERIMENT NO. 5 - DIAGRAM NO. 1:

Daily average temperatures of exposed bark and the air; and percent of relative humidity during the period July 15 to August 16, 1920.

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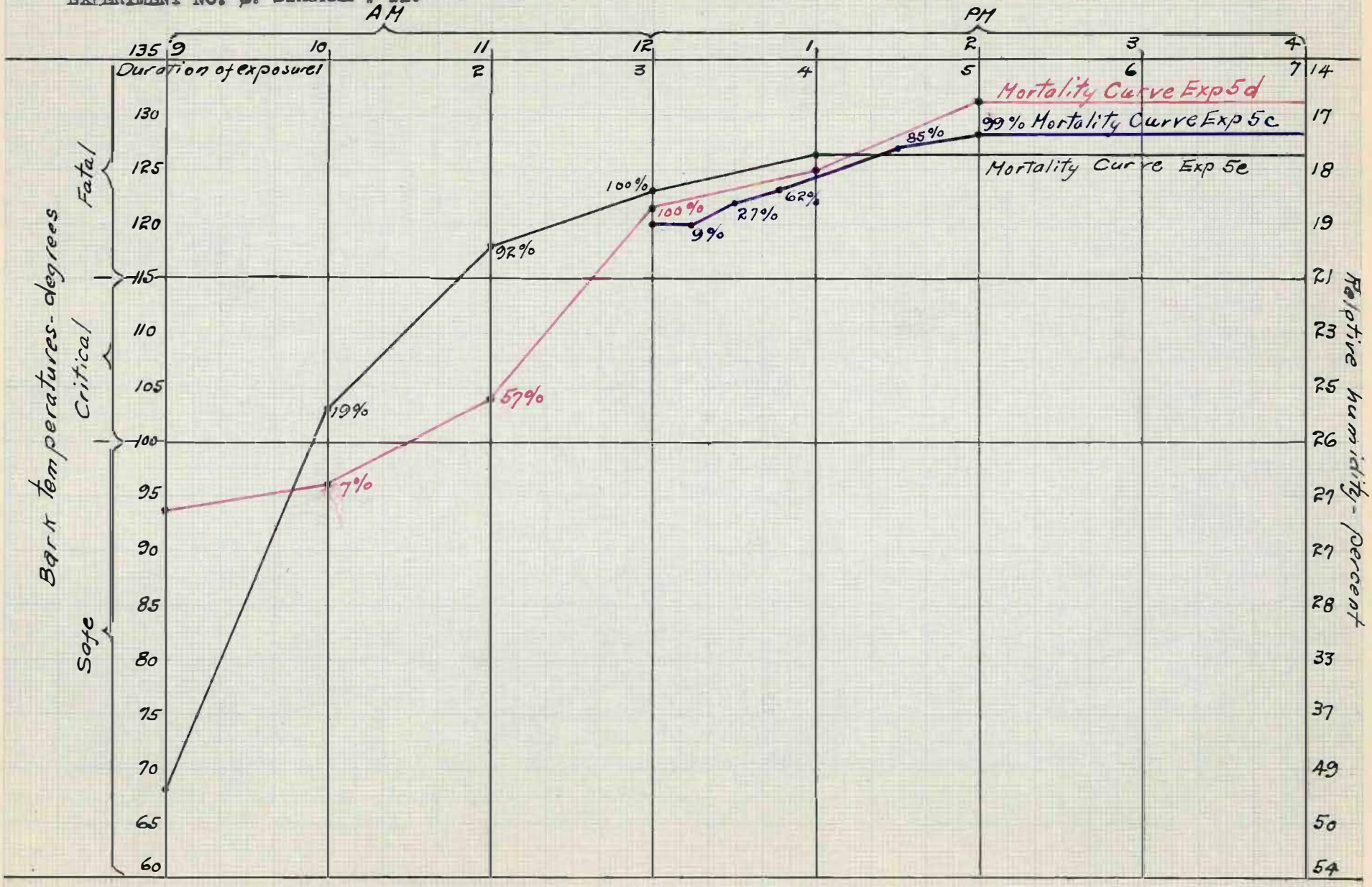
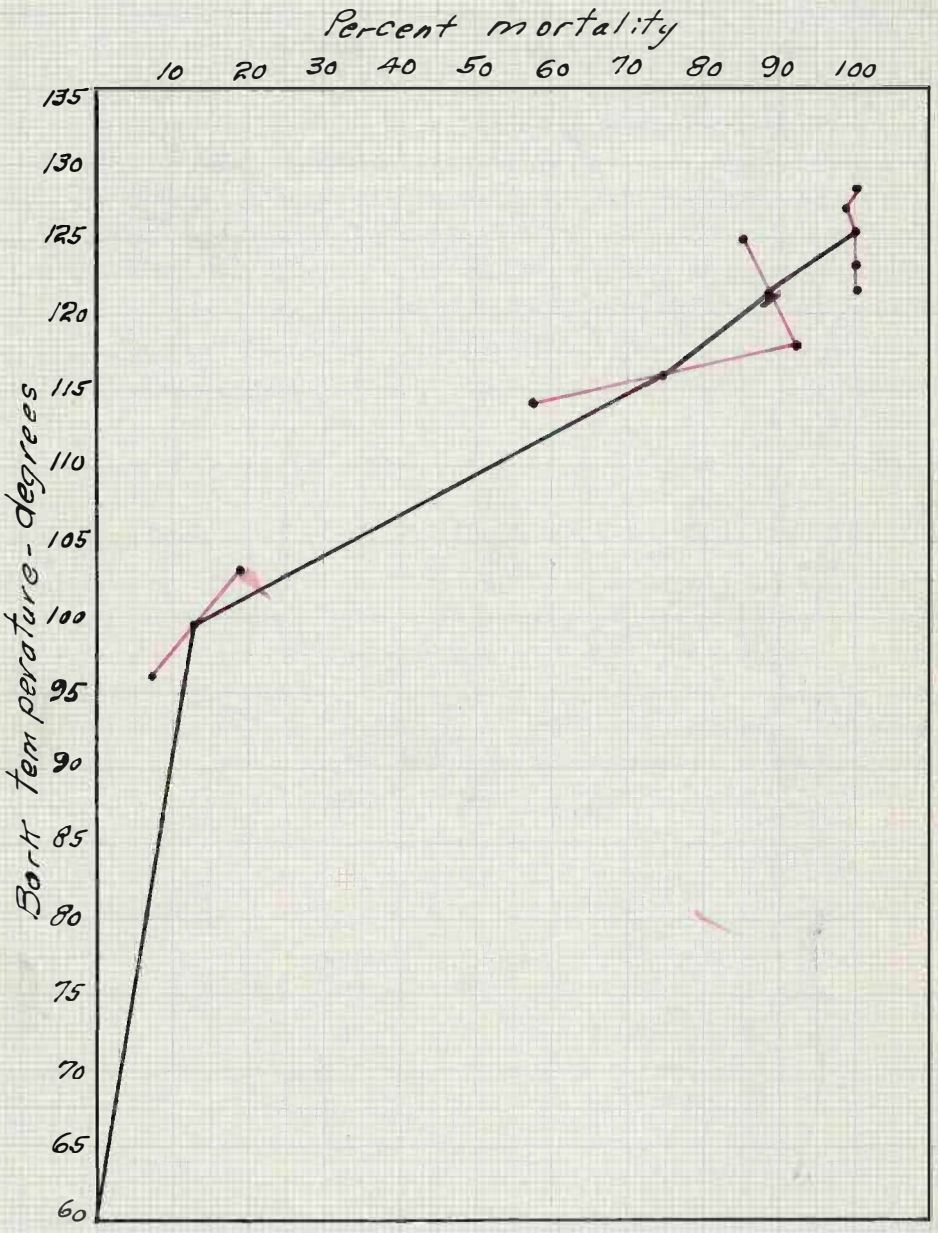
EXPERIMENT NO. 5: DIAGRAM # II.



Mortality curves and duration of exposures in tests 5c, 5d and 5e.

EXPERIMENT NO. 5 - DIAGRAM III.



Mortality curve as indicated by tests 5c, 5d, and 5e.

GENERAL CONCLUSIONS.

That the efficacy of this method of control of Dendroctonus brevicomis is well established. That in this latitude the method is productive of results fully equaling those of the established method of burning the infested bark.

The method is practicable and efficacious throughout the summer period when the maximum air temperatures ranges between 80 and 100 degrees.

The method is also applicable during the fire season, when burning infested bark would be extremely hazardous, and in forested areas where fire danger is excessive.

A certain range of maximum bark temperatures is a requisite to produce a sufficiently high brood mortality to make the method successful in application. These temperatures normally prevail during the summer period throughout the pine forests of this region. Bark temperatures above 115 degrees are productive of satisfactory results.

The tests indicate that:

Bark temperatures below 90 degrees are not sufficient to appreciably affect the mortality of the broods:

Critical bark temperatures range between 100 and 115 degrees. 40 to 90 percent of the broods are killed within this range of temperatures:

Bark temperatures above 120 degrees are approximately 100 percent fatal. Prolonged exposures at bark temperature of 115 degrees are 100 percent fatal. Absolute mortality is assured with one hours exposure at 130 degrees bark temperature.

Safe temperatures prevail before 10:AM and after 4:PM. During these periods tha maximum bark temperatures do not exceed 100 degrees.

Critical temperatures prevail during the periods from 10:AM to 11:AM and from 3:PM to 4:PM.

The minimum duration of exposure, 95 percent or more fatal to the broods, is 30 minutes.

During the early larval stage, (before the small larvae have entered the central layers of the outer bark) one days exposure of the bark under normal forest conditions, and even ins shaded positions, is 100 percent fatal to the broods. This is shown by Exp. 5a.

The percentage of relative humidity present in the air during the period of the tests did not appear to be a factor noticeably influencing the mortality. It would appear that a high relative humidity would lower the mortality at a given bark temperature. However, this was not determined, though the tests indicated that the bark temperatures and the duration of the exposure were the two factors controlling the mortality.

Respectfully submitted,

J. E. Patterson

Entomological Ranger.

Ashland, Oregon.
December 14,
1920.